SOIL SURVEY OF

Wagoner County, Oklahoma

United States Department of Agriculture
Soil Conservation Service

In cooperation with
Oklahoma Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period of 1964–71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Wagoner County Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Wagoner County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetical order by map symbol and gives the capability classification, tree suitability group, range site, and pasture and hayland suitability group in which the soil has been placed. It also shows the page on which range site is described.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability groups.

Foresters and others can refer to the section "Use of the Soils for Trees," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife Habitat."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and for recreation areas in the sections "Engineering Uses of the Soils" and "Use of the Soils for Recreational Development."

Engineers and builders can find, under "Engineering Uses of the Soils," estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Wagoner County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication.

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SOIL SURVEY OF WAGONER COUNTY, OKLAHOMA

BY DOCK J. POLONE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION

WAGONER COUNTY is in the northeastern part of Oklahoma (fig. 1). It is bounded on the west by Tulsa County, on the north by Rogers and Mayes Counties, on the east by Cherokee County, and on the south by Muskogee County. It has an area of approximately 380,800 acres, or 595 square miles. Wagoner, the county seat, is in the east-central part of the county. The elevation of the county ranges from 850 feet in the northeast to 500 feet in the southeast. At the county courthouse in Wagoner, the elevation is 578 feet above sea level.

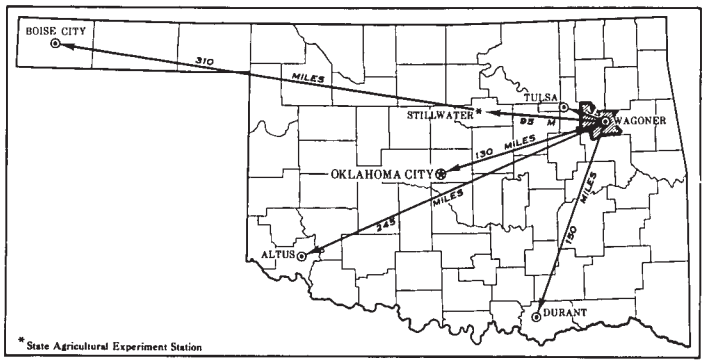

Figure 1.—**Location of Wagoner County in Oklahoma.**

Soils on uplands make up about 77 percent of the acreage; soils on bottom lands, 19 percent; and water areas, 4 percent.

The principal sources of income in Wagoner County are livestock and livestock products.

The county lies within three physiographic regimes —the Cherokee Prairie, the Boston Mountains, and the Ozark Highlands. The Cherokee Prairie makes up about 90 percent of the county and includes all but its eastern boundary. This consists mostly of the Ozark Highlands, but a small area of the Boston Mountains is in the northeast corner. The Cherokee Prairie is mostly prairie. Here the soils are used mainly for small grain, grain sorghum, cotton, and soybeans, but improved grasses and legumes for hay are grown as feed for livestock. The soils in the narrow eastern band are used for grazing livestock and for wood products. Some of the more nearly level soils have been cleared of trees and used for pasture and field crops.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Wagoner County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Coweta and Okay, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Dennis silt loam, 1 to 3 percent slopes, is one of several phases within the Dennis series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Wagoner County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen.

The Coweta-Bates complex, 2 to 5 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils or two or more. Radley soils, channeled, is an example. This group consists of two or more Radley soils that have different texture in the surface layer.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock outcrop is a land type in this county. It was mapped in a complex with Catoosa soils.

While a soil survey is in progress, the soil scientists take samples of soils for laboratory measurements and engineering tests. Laboratory data from the same kinds of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

The soil scientists also observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Wagoner County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Wagoner County are discussed in the following paragraphs. Not all soil names in Wagoner County general soil map are the same as those in Cherokee, Okmulgee, and Rogers Counties or in the recently completed and correlated survey of Mayes County. Most of the differences in names result from refinements in the system of soil classification during the period these counties were surveyed.

1. Dennis-Taloka-Okemah association

Deep, nearly level to gently sloping, moderately well drained and somewhat poorly drained soils on uplands

The soils in this association formed under a cover of grasses in material weathered from shale or in clayey and loamy sediment. They are on broad uplands and side slopes.

This association makes up about 46 percent of the survey area. About 43 percent of the association is Dennis soils; 27 percent is Taloka soils; 8 percent is

Okemah soils; and 22 percent is Bonn, clayey subsoil variant, Bates, Choteau, Coweta, Kanima, Parsons, Radley, and other less extensive soils.

Dennis soils are deep, moderately well drained, and loamy. They have a loamy or clayey subsoil over shale or clay. These are very gently sloping or gently sloping soils on broad, convex uplands.

Taloka soils are deep, somewhat poorly drained, and loamy. They have a loamy or clayey subsoil over loamy sediment. These are nearly level or very gently sloping soils on concave uplands.

Okemah soils are deep, moderately well drained, and loamy. They have a clayey subsoil over clayey or loamy sediment. These soils are nearly level, and they are in slightly concave positions on broad uplands.

About 65 percent of this association is used for tame pasture and such cultivated crops as soybeans, corn, grain sorghum, and small grain. The rest is used for range.

The principal concerns of management on this soil association are maintaining soil structure and fertility and controlling erosion. The soils respond favorably to good management.

2. *Coweta-Bates association*

Shallow and moderately deep, very gently sloping to steep, well drained and somewhat excessively drained soils on uplands

The soils in this association formed under a cover of grasses in material weathered from sandstone and shale. They are on broad uplands and side slopes.

This association makes up about 9 percent of the survey area. About 59 percent of the association is Coweta soils; 29 percent is Bates soils; and 12 percent is Dennis, Kamie, and other less extensive soils.

Coweta soils are shallow, well drained to somewhat excessively drained, and loamy. They have a loamy subsoil over sandstone and shale. These are very gently sloping soils on broad uplands and steep soils on side slopes that extend into drainageways.

Bates soils are moderately deep, well drained, and loamy. They have a loamy subsoil over sandstone. These are very gently sloping or gently sloping soils on broad uplands, generally below areas of Coweta soils.

Most of this association is used for range. Some is used for tame pasture and such cultivated crops as small grain and grain sorghum.

The principal concerns of management on this soil association are maintaining soil structure and fertility and controlling erosion.

3. *Summit-Catoosa association*

Deep and moderately deep, very gently sloping to sloping, moderately well drained and well drained soils on uplands

The soils in this association formed under a cover of grasses in material weathered from limestone or calcareous shale. They are on the tops and sides of upland ridges.

This association makes up about 1 percent of the survey area. About 55 percent of this association is Summit soils; 15 percent is Catoosa soils; and 30 percent is Dennis, Enders, Hector, Linker, Lula, Newtonia, Okemah, and Radley soils and Rock outcrop.

Summit soils are deep, moderately well drained, and loamy. They have a loamy or clayey subsoil over shale. These soils are on very gently sloping or gently concave side slopes on uplands.

Catoosa soils are moderately deep, well drained, and loamy. They have a loamy subsoil over limestone. These are very gently sloping to sloping soils on the tops of ridges on uplands.

About 50 percent of this association is used for tame pasture and such cultivated crops as small grain, grain sorghum, and soybeans. The rest is used for range.

The principal concerns of management on this soil association are controlling erosion and maintaining fertility and soil structure. The use of crop residue, fertilizer, and terraces helps to maintain the soil. When properly managed, these soils produce good range and pasture.

4. *Osage-Radley association*

Deep, nearly level to gently sloping, moderately well drained and poorly drained soils on flood plains

The soils in this association formed under a cover of forest and an understory of grasses in loamy or clayey sediment, mainly near major streams. They are on flood plains adjacent to streams.

This association makes up about 13 percent of the survey area. About 54 percent of this association is Osage soils; 38 percent is Radley soils; and 8 percent is Barge and other less extensive soils.

Osage soils are deep, poorly drained, and loamy or clayey. They have a clayey subsoil. These soils are subject to occasional flooding for brief periods during wet years. They are nearly level and are on the backwater part of the flood plain.

Radley soils are deep, moderately well drained, and loamy. They have loamy underlying sediment. These soils are subject to occasional flooding for brief periods during wet years. They are nearly level or gently sloping and are adjacent to the stream channel.

Most of this association is used for tame pasture and such cultivated crops as soybeans, corn, grain sorghum, small grain, and alfalfa.

The principal concerns of management on this association are maintaining soil structure and fertility and protecting the soils from damaging overflow. The Osage soils are wet. The soils respond favorably to good management.

5. *Hector-Enders association*

Shallow and deep, very gently sloping to very steep, well-drained soils on uplands

The soils in this association formed under a cover of forest and an understory of grasses in material weathered from sandstone and shale on ridges and side slopes.

This association makes up about 13 percent of the survey area. About 49 percent of this association is Hector soils; 22 percent is Enders soils; and 29 percent is Bates, Coweta, Dennis, Linker, Tullahassee, and other less extensive soils.

Hector soils are shallow, well drained, and loamy. They have a loamy subsoil over hard massive sandstone. These are very gently sloping soils on ridgetops to very steep soils on side slopes that extend into drainageways.

Enders soils are deep, well drained, and loamy. They have a loamy or clayey subsoil over weathered shale. These are sloping soils on ridgetops to steep soils on side slopes that extend into drainageways below areas of Hector soils.

Most of this association is woodland or is used for range or tame pasture.

The principal concerns of management on this soil association are controlling brush, maintaining soil fertility, and controlling water erosion.

6. *Choska-Mason-Tullahassee association*

Deep, nearly level, well drained and somewhat poorly drained soils on low terraces and flood plains

The soils in this association formed under a cover of hardwood forest and an understory of native grasses in loamy and clayey sediment. They are on low terraces or flood plains adjacent to streams.

This association makes up about 8 percent of the survey area. About 30 percent of this association is Choska soils; 21 percent is Mason soils; 17 percent is Tullahassee soils; and 32 percent is Kiomatia, Latanier, Moreland, and other less extensive soils.

Choska soils are deep, well drained, and loamy. They are underlain by loamy alluvium. They are subject to occasional flooding of brief duration during wet periods. These are nearly level soils on terraces.

Mason soils are deep, well drained, and loamy. They have a loamy subsoil over loamy sediment. These soils are on the higher parts of the terraces.

Tullahassee soils are deep, somewhat poorly drained, and loamy. They are underlain by loamy alluvium. These are nearly level soils on flood plains adjacent to the stream channel. They are subject to frequent flooding for long periods.

Most of this association is used for tame pasture and such cultivated crops as soybeans, small grain, grain sorghum, and corn.

The principal concerns of management on this soil association are maintaining soil structure and fertility and protecting the soils on flood plains from flooding. The soils respond favorably to good management.

7. *Kamie-Newtonia-Okay association*

Deep, very gently sloping to moderately steep, well-drained soils on uplands

The soils in this association formed a cover of native grasses or hardwood forest and an understory of grasses in loamy and sandy sediment. They are on uplands and side slopes that extend into drainageways.

This association makes up about 10 percent of the survey area. About 40 percent of this association is Kamie soils; 25 percent is Newtonia soils; 23 percent is Okay soils; and 12 percent is Dennis, Radley, and other less extensive soils.

Kamie soils are deep, well drained, and loamy or sandy. They have a loamy subsoil. These are very gently sloping soils on uplands to moderately steep soils on side slopes that extend into drainageways.

Newtonia soils are deep, well drained, and loamy. They have a loamy or clayey subsoil. These are very gently sloping or gently sloping soils on broad uplands above areas of Okay and Kamie soils.

Okay soils are deep, well drained, and loamy. They have a loamy subsoil. These are very gently sloping or gently sloping soils on broad ridges or side slopes that are intermediate between the Newtonia and Kamie soils.

Most of this association is used for tame pasture and such cultivated crops as grain sorghum, peaches, small grain, soybeans, corn, watermelons, and alfalfa.

The principal concerns of management on this soil association are maintaining soil structure and fertility and controlling erosion. The use of crop residue and fertilizer and terraces helps to maintain the soils and their productivity. Proper management of pasture and range results in good production of forage.

Descriptions of the Soils

In this section the soil series and mapping units of Wagoner County are described, and their use and management are discussed. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the soil series is representative of mapping units in that series. If the profile of a given mapping unit is different from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. Color terms are for moist soil unless otherwise stated.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit, range site, pasture and hayland suitability group, and tree suitability group in which the mapping unit has been placed. The page for the description of each range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Extent	Soil	Acres	Extent
Barge soils, 0 to 30 percent slopes	3,521	1.0	Kiomatia fine sandy loam	3,993	1.1
Bates fine sandy loam, 1 to 3 percent slopes	2,341	.7	Latanier clay	3,792	1.1
Bates fine sandy loam, 3 to 5 percent slopes	6,661	1.9	Linker fine sandy loam, 1 to 3 percent slopes	1,356	.4
Bates fine sandy loam, 3 to 5 percent slopes, eroded	672	.2	Lula silt loam, 1 to 3 percent slopes	465	.1
Bonn silt loam, clayey subsoil variant	561	.2	Mason silt loam	5,834	1.6
Catoosa-Rock outcrop complex, 1 to 8 percent slopes	1,396	.4	Moreland clay	1,511	.4
Choska silt loam	8,287	2.3	Newtonia silt loam, 1 to 3 percent slopes	2,166	.6
Choteau silt loam, 1 to 3 percent slopes	3,657	1.0	Newtonia silt loam, 3 to 5 percent slopes	4,811	1.3
Coweta-Bates complex, 2 to 5 percent slopes	29,271	8.1	Newtonia silt loam, 2 to 5 percent slopes, eroded	1,546	.5
Coweta stony soils, 5 to 30 percent slopes	6,821	1.9	Okay loam, 1 to 3 percent slopes	5,067	1.4
Dennis silt loam, 1 to 3 percent slopes	30,802	8.4	Okay loam, 3 to 5 percent slopes	2,704	.8
Dennis silt loam, 3 to 5 percent slopes	24,143	6.7	Okemah silt loam, 0 to 1 percent slopes	13,203	3.7
Dennis silt loam, 2 to 5 percent slopes, eroded	5,251	1.5	Osage silty clay loam	15,553	4.3
Dennis-Radley complex, 0 to 15 percent slopes	24,982	6.9	Osage clay	9,349	2.6
Hector-Enders complex, 5 to 30 percent slopes	27,227	7.7	Parsons silt loam, 0 to 1 percent slopes	5,815	1.6
Hector-Linker complex, 1 to 5 percent slopes	16,375	4.5	Radley silt loam	6,273	1.7
Hector soils, 20 to 50 percent slopes	4,742	1.3	Radley soils, channeled	11,022	3.1
Kamie loamy fine sand, 5 to 20 percent slopes	914	.2	Summit silty clay loam, 1 to 3 percent slopes	1,229	.3
Kamie fine sandy loam, 1 to 5 percent slopes	3,821	1.0	Summit silty clay loam, 3 to 5 percent slopes	1,033	.3
Kamie fine sandy loam, 2 to 5 percent slopes, eroded	6,123	1.7	Taloka silt loam, 0 to 1 percent slopes	18,661	5.2
Kamie soils, 2 to 8 percent slopes, severely eroded	2,260	.6	Taloka silt loam, 1 to 3 percent slopes	26,164	7.3
Kanima soils, 3 to 50 percent slopes	2,850	.8	Tullahassee fine sandy loam	4,710	1.3
			Borrow pits	1,256	.3
			Total	[1] 360,192	100.0

[1] Land area only. Does not include 20,608 acres of water area.

methods of soil mapping can be obtained from the Soil Survey Manual.[1]

Barge Series

The Barge series consists of deep, nearly level to steep soils on uplands. These soils formed in loamy material that had been excavated during the development of waterway channels.

In a representative profile the surface layer is 7 inches of brown silty clay loam. The underlying material, to a depth of 72 inches, is dark yellowish-brown silty clay loam that has fragments of darker material throughout.

Barge soils are well drained and are moderately slowly permeable. Available water capacity is high.

Representative profile of Barge silty clay loam in an area of Barge soils, 0 to 30 percent slopes, 2,600 feet east and 1,100 feet north of the southwest corner of sec. 9, T. 19 N., R. 16 E:

Ap—0 to 7 inches, brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; weak, fine, granular structure; hard, firm; neutral; gradual, wavy boundary.

C—7 to 72 inches, dark yellowish-brown (10YR 3/4) silty clay loam, dark yellowish brown (10YR 4/4) dry; common, fine, distinct, gray, dark reddish-brown, and strong-brown mottles; massive; firm; very hard; few fragments or pockets of very dark grayish-brown (10YR 3/2) granular silt loam; neutral.

The A horizon is brown, dark-brown, very dark grayish-brown, or dark grayish-brown silty clay loam or clay loam. It is slightly acid to mildly alkaline.

The C horizon is dark-brown, brown, or dark yellowish-brown silty clay loam or clay loam. It includes parts of A, B, and C horizons of soils that existed before excavation. This horizon is mottled in shades of brown, gray, or red.

Barge soils are associated with Osage and Radley soils. The Barge soils lack the dark, thick A horizon of the Osage and Radley soils.

Barge soils, 0 to 30 percent slopes (BaF).—These nearly level to steep soils are on uplands. They consist of spoil-bank material excavated during waterway channel development (fig. 2). These soils have the profile described as representative for the Barge series, except the surface layer ranges from silty clay loam to clay loam.

Included with these soils in mapping are spots of Osage and Radley soils and spots of soils similar to Barge soils except the underlying material is more clayey or more sandy below the surface layer than it is in recognized soils of the Barge series.

Areas of these soils are used mainly for wildlife habitat and recreation.

Management is needed that maintains or improves cover of grass and trees. Capability unit VIIe-1; pasture and hayland suitability group 8A; tree suitability group 7. Not assigned to a range site.

Bates Series

The Bates series consists of moderately deep, very gently sloping and gently sloping soils on upiands. These soils formed under a cover of native grasses in material weathered from sandstone.

In a representative profile the surface layer is 14 inches of very dark grayish-brown fine sandy loam. The upper part of the subsoil, extending to a depth of 19 inches, is dark-brown loam. The lower part, extending to a depth of 32 inches, is dark-brown clay loam. Yellowish-brown sandstone is at a depth of 32 inches.

[1] United States Department of Agriculture, Soil Survey Manual, U.S. Dep. Agric. Handb. No. 18, 503 pp., illus. 1951.

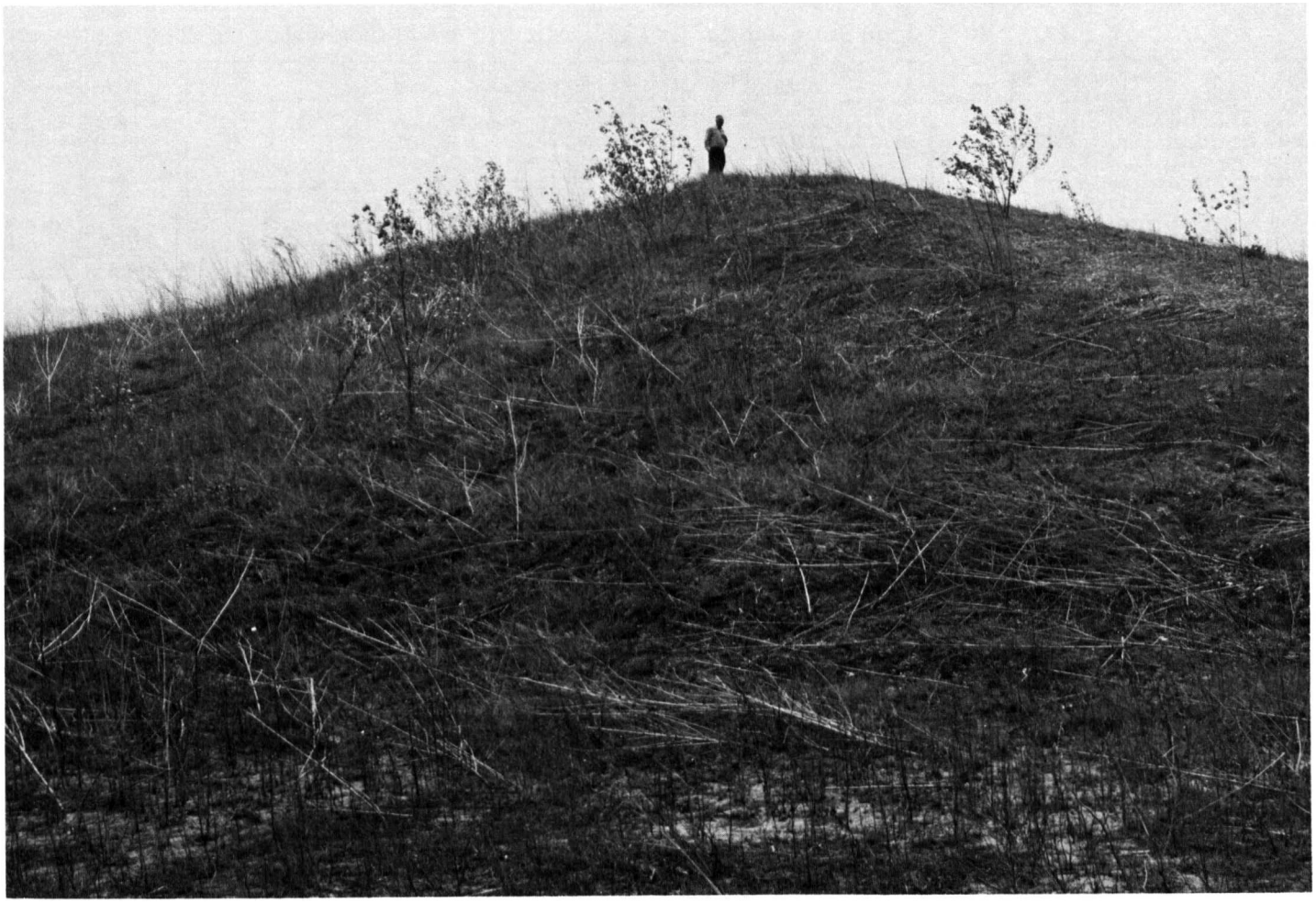

Figure 2.—Area of Barge soils, 0 to 30 percent slopes.

Bates soils are well drained and are moderately permeable. Available water capacity is moderate.

Representative profile of Bates fine sandy loam, 3 to 5 percent slopes, 400 feet east and 50 feet north of the southwest corner of sec. 11, T. 18 N., R. 15 E.:

A1—0 to 14 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate, fine, granular structure; friable; slightly hard; many roots; medium acid; gradual, smooth boundary.

B1—14 to 19 inches, dark-brown (10YR 3/3) loam, brown (10YR 5/3) dry; few, fine, faint, yellowish-brown mottles; moderate, medium, granular structure; friable; slightly hard; many roots; strongly acid; gradual, smooth boundary.

B2t—19 to 28 inches, dark-brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; common, fine, distinct, reddish-brown mottles; moderate, medium, subangular blocky structure; firm; hard; thin patchy clay films on surface; strongly acid; gradual, smooth boundary.

B3—28 to 32 inches, dark-brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; few, fine, distinct, yellowish-red mottles; moderate, medium, subangular blocky structure; very firm; very hard; many, fine, sandstone fragments; strongly acid; gradual, wavy boundary.

R—32 inches, yellowish-brown (10YR 5/4) sandstone; strongly acid.

The A1 horizon is very dark brown or very dark grayish brown. It is strongly acid or medium acid.

The B1 horizon is dark-brown or brown loam or clay loam. It is slightly acid to strongly acid.

The B2t horizon is brown, dark-brown, dark yellowish-brown, or yellowish-brown clay loam or sandy clay loam. It is medium acid or strongly acid. This horizon has mottles in shades of brown or red.

The B3 horizon is brown, dark-brown, yellowish-brown, or dark yellowish-brown clay loam or sandy clay loam. It is medium acid or strongly acid.

Sandstone bedrock is at a depth of 20 to 40 inches.

Bates soils are associated with Coweta and Dennis soils. The Bates soils have a Bt horizon lacking in the Coweta soils, which have a solum that ranges from 10 to 20 inches in thickness. Bates soils have a thinner solum and are less clayey in the Bt horizon than the Dennis soils.

Bates fine sandy loam, 1 to 3 percent slopes (BbB).—This very gently sloping soil is on uplands (fig. 3).

Included with this soil in mapping, and making up about 20 percent of the acreage, is a soil that is similar to this soil, but has sandstone at a depth of more than 40 inches. Included areas of Coweta soils make up 5 percent of the acreage, and included areas of Dennis soils, 6 percent.

Areas of this soil are used mostly for small grain, grain sorghum, soybeans, corn, alfalfa, tame pasture, and range.

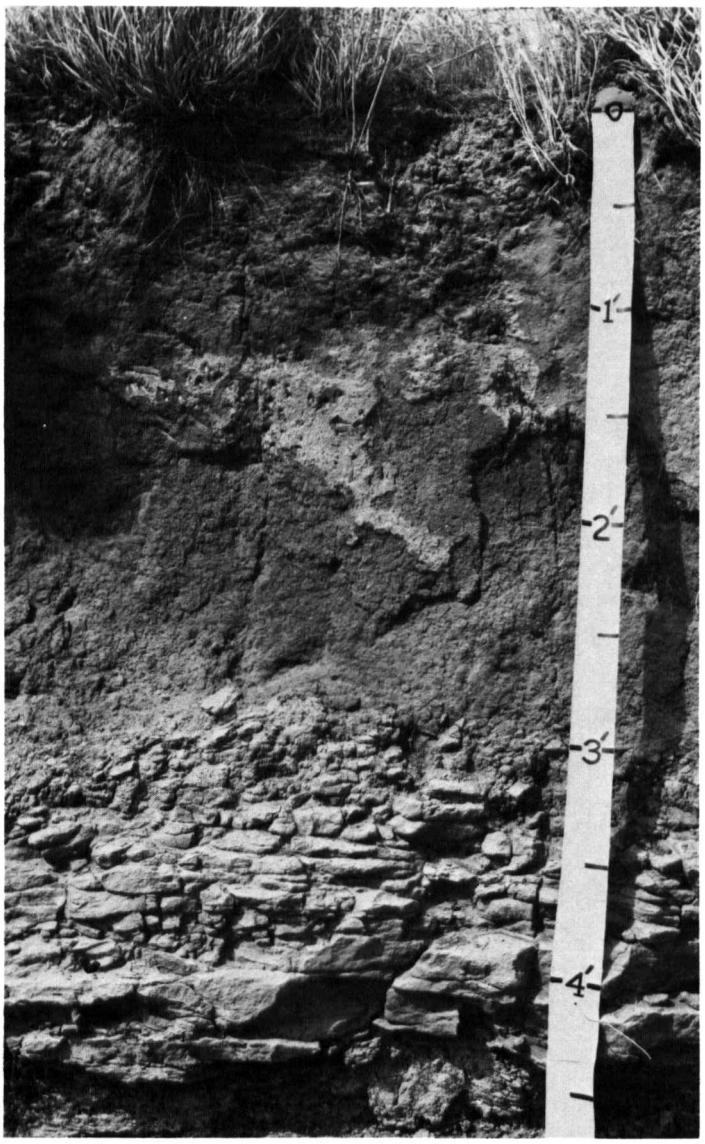

Figure 3.—**Profile of Bates fine sandy loam showing sandstone bedrock at a depth of about 3 feet.**

Management is needed that maintains fertility and soil structure and that controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Bates fine sandy loam, 3 to 5 percent slopes (BbC).—This gently sloping soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 20 percent of the acreage, is a soil that is similar to Bates soils but has sandstone at a depth of more than 40 inches. Included areas of Dennis soils and Coweta soils each make up 4 percent of the acreage.

Areas of this soil are used mostly for grain sorghum, soybeans, small grain, corn, tame pasture, and range.

Management is needed that maintains or improves soil structure and fertility and that controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Bates fine sandy loam, 3 to 5 percent slopes, eroded (BbC2).—This moderately eroded, gently sloping soil is on uplands. It has a profile similar to the one described as representative of the series, except the surface layer has been thinned by erosion. A few places have rills and gullies ranging in depth from 6 to 48 inches. The surface layer and subsoil have been mixed by cultivation in about 20 percent of the area.

Included with this soil in mapping, and making up about 20 percent of the acreage, is a soil that is similar to Bates soils but is more than 40 inches deep over sandstone. A soil that is similar to Bates soils but has a surface layer of loam makes up 5 percent of the acreage. Included areas of Coweta soils make up 6 percent of the acreage; Dennis soils, 4 percent; and gullies, 5 percent.

Areas of this soil are used mostly for wheat, soybeans, grain sorghum, tame pasture, and range.

Management is needed that maintains or improves soil structure and fertility and that controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-3; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Bonn, Clayey Subsoil Variant

The Bonn, clayey subsoil variant, consists of deep, nearly level soils on uplands. These soils formed under a cover of native grasses in clayey sediment.

In a representative profile the surface layer is 4 inches of dark grayish-brown silt loam. The subsoil, extending to a depth of 60 inches, is dark-gray clay.

Bonn, clayey subsoil variants, are poorly drained and are very slowly permeable. Available water capacity is high. These soils have a seasonal high water table at a depth of 0 to 0.5 feet for short periods during wet seasons.

Representative profile of Bonn silt loam, clayey subsoil variant, 1,300 feet west and 100 feet north of the southeast corner of sec. 12, T. 16 N., R. 18 E.:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak, fine, granular structure; friable; hard; few fine roots; neutral; abrupt, smooth, boundary.

B21tg—4 to 30 inches, dark-gray (10YR 4/1) clay; weak, medium, subangular blocky structure; extremely firm; extremely hard; shiny pressure faces; thin silt coatings on some ped surfaces; many fine crystals; neutral; gradual, smooth boundary.

B22tg—30 to 60 inches, dark-gray (10YR 4/1) clay; few, medium, distinct, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; extremely firm; extremely hard; pressure faces on peds; few medium-sized crystals; few dark concretions; mildly alkaline.

The A1 horizon is very dark gray, very dark grayish brown, dark gray, or dark grayish brown. It is neutral to strongly acid.

The B21tg horizon is dark gray or dark grayish brown. It has few to many crystals. The exchangeable sodium percentage is more than 15 percent. This horizon is neutral or mildly alkaline.

The B22tg horizon is dark gray or dark grayish brown. It has few to many crystals. This horizon is neutral or mildly alkaline.

Bonn soils, clayey subsoil variant, are associated with Okemah and Parsons soils. They have a thinner, lighter colored A horizon and a less clayey Bt horizon than Okemah soils. The Bonn soils lack the A2 horizon of Parsons soils, and they have a less clayey B2t horizon than those soils.

Bonn silt loam, clayey subsoil variant (Bv).—This nearly level soil is on uplands.

Included with this soil in mapping are about 16 percent Okemah soils, 15 percent Parsons soils, and 2 percent slickspots.

Areas of this soil are used mainly for tame pasture plants and native range. The main concerns of management are slow intake of water, seasonal wetness or droughty conditions, and maintenance of soil structure and fertility.

Management is needed to maintain or improve stands of grasses. Capability unit IVs-1; Shallow Claypan range site; pasture and hayland suitability group 8D; tree suitability group 10.

Catoosa Series

The Catoosa series consists of moderately deep, very gently sloping to sloping soils on uplands. These soils formed under a cover of native grasses in material weathered from limestone.

In a representative profile the surface layer is 7 inches of dark reddish-brown silt loam. The subsoil, extending to a depth of 28 inches, is dark reddish-brown silty clay loam. Limestone bedrock is at a depth of 28 inches.

Catoosa soils are well drained and are moderately permeable. Available water capacity is moderate.

Representative profile of Catoosa silt loam in an area of Catoosa-Rock outcrop complex, 1 to 8 percent slopes, 2,640 feet east and 500 feet south of the northwest corner of sec. 6, T. 19 N., R. 15 E.:

A1—0 to 7 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/3) dry; moderate, fine, granular structure; friable; slightly hard; common fine roots; slightly acid; gradual, smooth boundary.

B1—7 to 12 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; moderate, medium, granular structure; friable; hard; common fine roots; slightly acid; gradual, smooth boundary.

B2t—12 to 28 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) dry; moderate, medium, subangular blocky structure; firm; very hard; few fine roots; nearly continuous clay films on ped surfaces; few, fine, dark concretions; slightly acid; abrupt, wavy boundary.

R—28 inches, limestone bedrock.

The A1 horizon is dark brown, dark reddish brown, dark reddish gray, or reddish brown. It is slightly acid or medium acid.

The B1 horizon is dark-brown, dark reddish-brown, reddish-brown, or dark reddish-gray silt loam or silty clay loam. It is slightly acid or medium acid.

The B2t horizon is dark reddish-brown, reddish-brown, dark-red, yellowish-red, or dark-brown silty clay loam or clay loam. It is medium acid or slightly acid.

Depth to limestone bedrock ranges from 20 to 40 inches.

Catoosa soils are associated with Lula and Summit soils. They differ from Lula and Summit soils by having limestone bedrock at a depth of less than 40 inches. In addition, Catoosa soils do not open and close during dry years and are less clayey in the upper part of the Bt horizon than Summit soils.

Catoosa-Rock outcrop complex, 1 to 8 percent slopes (CcD).—This complex is on uplands. The Catoosa soil in this complex has the profile described as representative for the Catoosa series. Rock outcrop is a land type consisting of bare limestone bedrock or bedrock that has a mantle of soil material less than 3 inches thick.

Catoosa silt loam makes up about 46 percent of this complex. Rock outcrop makes up 21 percent.

Included with these soils in mapping, and making up 24 percent of the acreage, is a soil that is similar to Catoosa soils but has bedrock at a depth of 4 to 20 inches. Included areas of Lula silt loam make up 9 percent of the acreage.

Areas of these soils are used mainly for range (fig. 4).

Management is needed that maintains or improves stands of desirable grasses. Capability unit VIIs-1; Catoosa soils in Loamy Prairie range site, Rock outcrop not assigned to a range site; Catoosa soils in pasture and hayland suitability group 8A, Rock outcrop not assigned to a pasture and hayland suitability group; Catoosa soils in tree suitability group 7, Rock outcrop not assigned.

Choska Series

The Choska series consists of deep, nearly level soils on low terraces. These soils formed under a cover of hardwood forest and an understory of native grasses in loamy sediment.

In a representative profile the surface layer is 14 inches of dark-brown silt loam. The upper part of the underlying layer, extending to a depth of 36 inches, is yellowish-red very fine sandy loam. The middle part, to a depth of 48 inches, is yellowish-red silt loam. The lower part, to a depth of 66 inches, is reddish-brown loamy fine sand.

Choska soils are well drained and are moderately permeable. Available water capacity is high.

Representative profile of Choska silt loam, 1,400 feet east and 150 feet south of the northwest corner of sec. 5, T. 16 N., R. 16 E.:

A1—0 to 14 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; moderate, fine, granular structure; very friable; soft; few fine roots; few medium pores; slightly acid; clear, smooth boundary.

C1—14 to 36 inches, yellowish-red (5YR 4/6) very fine sandy loam, yellowish red (5YR 5/6) dry; massive; very friable; soft; thin strata of loamy fine sand to silty clay loam; neutral; clear, smooth boundary.

C2—36 to 48 inches, yellowish-red (5YR 4/6) silt loam, yellowish red (5YR 5/6) dry; massive; friable; slightly hard; thin strata of loamy fine sand to clay; calcareous; moderately alkaline; clear, smooth boundary.

C3—48 to 66 inches, reddish-brown (5YR 5/4) loamy fine sand, light reddish brown (5YR 6/4) dry; single

Figure 4.— **Native grass range in an area of Catoosa-Rock outcrop complex, 1 to 8 percent slopes.**

grained; loose; bedding planes evident; calcareous; moderately alkaline.

The A1 horizon is dark reddish brown or dark brown. It is slightly acid to mildly alkaline.

The C horizon is yellowish red, brown, dark brown, reddish brown, red, or strong brown. The C1 and C2 horizons are dominantly silt loam or very fine sandy loam but include thin strata of finer or coarser material. These horizons are commonly stratified and are neutral to moderately alkaline. The C3 horizon is dominantly loamy fine sand but has strata of finer or coarser material.

Choska soils are associated with Kiomatia, Mason, Radley, and Tullahassee soils. They have a darker, thicker A horizon than Kiomatia or Tullahassee soils. Choska soils lack the Bt horizon of Mason soils and are less clayey between depths of 10 and 40 inches than Radley soils.

Choska silt loam (Cd).—This nearly level soil is on low terraces. It is subject to occasional flooding of short duration during wet periods.

Included with this soil in mapping, and making up about 20 percent of the acreage, is a soil that is similar to Choska soils but has a brown surface layer. Included areas of Kiomatia, Latanier, Moreland, and Mason soils each make up 5 percent of the acreage.

Areas of this soil are used mainly for small grain, alfalfa, soybeans, grain sorghum, corn, cotton, tame pasture plants, and truck crops.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, minimum tillage, no tillage, and arrangement of rows for drainage. Capability unit I-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 1.

Choteau Series

The Choteau series consists of deep, very gently sloping soils on uplands. These soils formed under a cover of native grasses in clayey or loamy sediment.

In a representative profile the surface layer is 16 inches of very dark grayish-brown silt loam. The subsurface layer, extending to a depth of 24 inches, is brown silt loam. The upper part of the subsoil, extending to a depth of 30 inches, is yellowish-brown silty clay loam. The middle part, to a depth of 52 inches, is yellowish-brown clay. The lower part, extending to a depth of 65 inches, is coarsely mottled, yellowish-brown, brownish-yellow, grayish-brown, and strong-brown clay.

Choteau soils are moderately well drained and are slowly permeable. Available water capacity is high.

This soil has a seasonal water table between depths of 2 and 3 feet for short duration during wet periods.

Representative profile of Choteau silt loam, 1 to 3 percent slopes, 1,320 feet east and 100 feet north of the southwest corner of sec. 19, T. 17 N., R. 18 E.:

A1—0 to 16 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; friable; slightly hard; strongly acid; clear, smooth boundary.

A2—16 to 24 inches, brown (10YR 5/3) silt loam; pale brown (10YR 6/3) dry; moderate, medium, granular structure; friable; slightly hard; strongly acid; clear, smooth boundary.

B1—24 to 30 inches, yellowish-brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; few, fine, faint, brownish-yellow and grayish-brown mottles; weak, fine, subangular blocky structure; friable; hard; strongly acid; gradual, smooth boundary.

B2t—30 to 52 inches, yellowish-brown (10YR 5/6) clay; many, medium, distinct, strong-brown (7.5YR 5/6), red (2.5YR 4/6), and brownish-yellow (10YR 6/6) mottles; moderate, medium, blocky structure; very firm; extremely hard; patchy clay films on ped surfaces; strongly acid; gradual, smooth boundary.

B3—52 to 65 inches, coarsely mottled yellowish-brown (10YR 5/6), brownish-yellow (10YR 6/6), grayish-brown (10YR 5/2), and strong-brown (7.5YR 5/6) clay; weak, coarse, blocky structure; very firm; very hard; patchy clay films on ped surfaces; slightly acid.

The A1 horizon is very dark grayish brown, very dark brown, or dark brown. It is slightly acid to strongly acid.

The A2 horizon is dark grayish brown, light brownish gray, brown, pale brown, or grayish brown. It is medium acid to very strongly acid.

The B1 horizon is very dark grayish-brown, dark yellowish-brown, yellowish-brown, dark-brown, or brown silty clay loam or clay loam. It is medium acid to very strongly acid.

The B2t horizon is brown, dark-brown, strong-brown, dark yellowish-brown, or yellowish-brown silty clay loam, silty clay, clay, or clay loam. It is slightly acid to strongly acid. This horizon is mottled in shades of red, yellow, gray, or brown.

The B3 horizon is coarsely mottled in shades of brown, yellow, or gray. It is silty clay loam, silty clay, clay loam, or clay. This horizon is medium acid to mildly alkaline.

Choteau soils are associated with Dennis, Okemah, and Taloka soils. Unlike Dennis soils, which have an A horizon less than 16 inches thick, Choteau soils have an A horizon that is more than 16 inches thick. Choteau soils have an A2 horizon that Okemah soils lack. Choteau soils lack the abrupt textural change between the A and Bt horizons that is characteristic of Taloka soils.

Choteau silt loam, 1 to 3 percent slopes (ChB).—This very gently sloping soil is on uplands.

Included with this soil in mapping, and making up about 6 percent of the acreage, is a soil that is similar to this soil but has a brown surface layer. Included areas of Dennis soils make up 12 percent of the acreage; Newtonia soils, 8 percent; and Taloka soils, 7 percent.

Areas of this soil are used mainly for small grain, corn, soybeans, grain sorghum, alfalfa, tame pasture plants, and range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Coweta Series

The Coweta series consists of shallow, very gently sloping to steep soils on uplands. These soils formed under a cover of native grasses in material weathered from sandstone and shale.

In a representative profile the surface layer is 8 inches of dark-brown loam. The subsoil, extending to a depth of 15 inches, is dark-brown fine sandy loam. The underlying material, to a depth of 30 inches, is strong-brown and yellowish-red, soft sandstone interbedded with shale.

Coweta soils are well drained to somewhat excessively drained and moderately permeable. Available water capacity is moderate.

Representative profile of Coweta loam in an area of the Coweta-Bates complex, 2 to 5 percent slopes, 2,050 feet west and 50 feet south of the northeast corner of sec. 29, T. 19 N., R. 15 E.:

A1—0 to 8 inches, dark-brown (7.5YR 3/2) loam, brown (7.5YR 5/2) dry; moderate, fine, granular structure; friable; slightly hard; many fine and medium roots; few sandstone fragments; medium acid; gradual, wavy boundary.

B2—8 to 15 inches, dark-brown (7.5YR 4/4) fine sandy loam, brown (7.5YR 5/4) dry; weak, fine, granular structure; friable; slightly hard; 20 percent soft sandstone fragments less than 3 inches in diameter; 10 percent sandstone fragments 3 to 10 inches in diameter; medium acid; abrupt, wavy boundary.

C—15 to 30 inches, strong-brown (7.5YR 5/6) and yellowish-red (5YR 5/8) soft sandstone interbedded with shale; strongly acid.

The A1 horizon is dark-brown or very dark grayish-brown stony loam, loam, or fine sandy loam. It is slightly acid to strongly acid. Coarse sandstone fragments make up 0 to 20 percent of the volume. The B2 horizon is brown, dark-brown, dark grayish-brown, dark yellowish-brown, yellowish-brown, strong-brown, yellowish-red, or reddish-brown fine sandy loam, loam, clay loam, or their gravelly or stony counterparts. It is slightly acid to strongly acid. Coarse sandstone fragments make up 15 to 30 percent of the volume.

The thickness of the solum and depth to rippable sandstone is 10 to 20 inches.

The C horizon is slightly acid to strongly acid.

Coweta soils are associated with Bates and Dennis soils. They are shallower than Bates soils. Coweta soils have a coarser-textured B horizon and a thinner solum than Dennis soils. They lack a B2t horizon, which both Bates and Dennis soils have.

Coweta-Bates complex, 2 to 5 percent slopes (CkC).—These very gently sloping or gently sloping soils are on uplands.

Coweta loam makes up 55 percent of this complex. Bates fine sandy loam makes up 25 percent.

Included with these soils in mapping, and making up 5 percent of the acreage, is a soil that is similar to Coweta loam but has hard bedrock at a depth of less than 20 inches. Included areas of Dennis silt loam make up 5 percent of the acreage; Rock outcrop, 2 percent; and shallow, clayey soils over shale, 8 percent.

Areas of these soils are used mainly for range and tame pasture plants.

Management is needed that maintains or improves stands of desirable grasses and that controls brush and undesirable vegetation. Capability unit VIe-4; tree suitability group 6; Coweta soils in Shallow Prairie range

site and pasture and hayland suitability group 14A; Bates soils in Loamy Prairie range site and pasture and hayland suitability group 8A.

Coweta stony soils, 5 to 30 percent slopes (CsF).—These sloping to steep soils are on uplands. They have a profile similar to that described as representative of the Coweta series, except the surface layer ranges from loam to fine sandy loam and contains fragments larger than 10 inches in diameter (fig. 5) throughout.

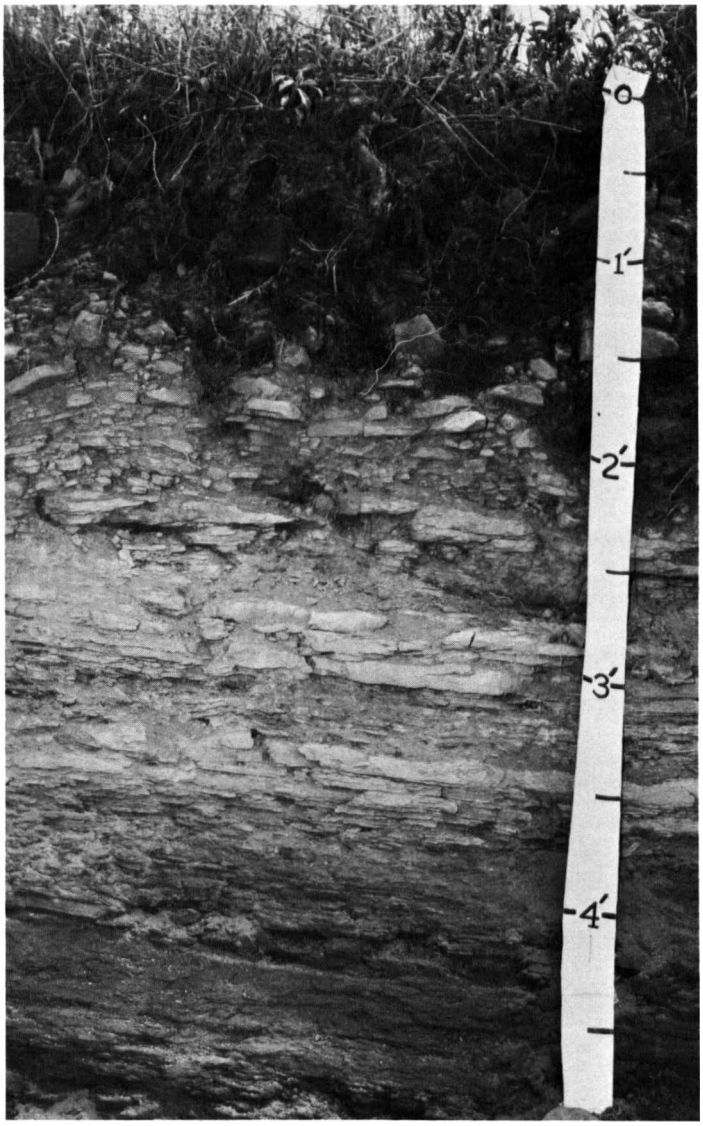

Figure 5.—**Profile of Coweta loam showing the fragments throughout the soil and irregular depth to rippable bedrock.**

Included with these soils in mapping, and making up about 20 percent of the acreage, is a soil that is similar to Coweta soils but has hard sandstone bedrock at a depth of less than 20 inches. Included spots of Rock outcrop make up 4 percent of the acreage, and a soil that is similar to Coweta soils but is less than 20 inches deep to shale makes up 6 percent.

Areas of these soils are used for range.

Management is needed that maintains or improves stands of desirable grasses. The control of brush and undesirable vegetation requires proper grazing practices and prevention of burning. Capability unit VIIs-1; Shallow Prairie range site; pasture and hayland suitability group 14A; tree suitability group 6.

Dennis Series

The Dennis series consists of deep, very gently sloping and gently sloping soils on uplands. These soils formed under a cover of native grasses in material weathered from shale or clay.

In a representative profile the surface layer is 16 inches of very dark brown silt loam. The upper part of the subsoil, extending to a depth of 24 inches, is dark-brown silty clay loam. The next part, to a depth of 46 inches, is dark yellowish-brown silty clay loam. Below this, to a depth of 50 inches, is dark yellowish-brown clay loam. The lower part, extending to a depth of 64 inches, is coarsely mottled dark yellowish-brown, pale-brown, very dark brown, and dark grayish-brown clay.

Dennis soils are moderately well drained and are slowly permeable. Available water capacity is high. These soils have a seasonal high water table at a depth of 2 to 3 feet for a short duration during wet periods.

Representative profile of Dennis silt loam, 1 to 3 percent slopes, 300 feet north and 100 feet east of the southwest corner of sec. 5, T. 17 N., R. 16 E.:

A1—0 to 16 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate, medium, granular structure; friable, slightly hard; few dark-brown (10YR 4/3) stains in lower part; medium acid; gradual, smooth boundary.

B1—16 to 24 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; few, medium, faint, grayish-brown (10YR 5/2) mottles; moderate, medium, granular structure; friable; slightly hard; few dark concretions; medium acid; gradual, smooth boundary.

B21t—24 to 46 inches, dark yellowish-brown (10YR 4/4) silty clay loam; many, medium, distinct, light yellowish-brown (10YR 6/4), grayish-brown (10YR 5/2), and dark-brown (7.5YR 4/4) mottles; moderate, medium, subangular blocky structure; very firm; very hard; few dark concretions; clay films on ped surfaces; strongly acid; gradual, smooth boundary.

B22t—46 to 50 inches, dark yellowish-brown (10YR 4/4) clay loam; common, medium, distinct, light brownish-gray (10YR 6/2), pale brown (10YR 6/3), and dark grayish-brown (10YR 4/2) mottles; moderate, medium, subangular blocky structure; very firm; very hard; clay films on ped surfaces; slightly acid; gradual, smooth boundary.

B3—50 to 64 inches, coarsely mottled dark yellowish-brown (10YR 4/4), pale-brown (10YR 6/3), dark grayish-brown (10YR 4/2), and very dark brown (10YR 2/2) clay; moderate, medium, subangular blocky structure; very firm; very hard; slightly acid.

The A1 horizon is very dark brown or very dark grayish brown. It is medium acid or strongly acid.

The B1 horizon is brown, dark-brown, or dark yellowish-brown silty clay loam or clay loam. It is medium acid to very strongly acid.

The B2t horizon is brown, dark-brown, dark yellowish-brown, or yellowish-brown silty clay loam, clay loam, or clay. It is slightly acid to strongly acid. This horizon has mottles in shades of gray, brown, or red.

The B3 horizon is coarsely mottled in shades of brown, yellow, or gray. It is silty clay loam, clay loam, or clay. This horizon is slightly acid or medium acid.

Dennis soils are associated with Bates, Choteau, Coweta, and Okemah soils. The Dennis soils lack bedrock at a depth of less than 60 inches and are more clayey in the B horizon than the Bates or Coweta soils. Unlike the Choteau soils, which have an A horizon more than 16 inches thick, the Dennis soils have an A horizon less than 16 inches thick. Also, the Dennis soils either lack an A2 horizon or have an A2 horizon that is thinner than that in the Choteau soils. Dennis soils have high-chroma mottles in the B horizon, and they lack the A3 horizon of Okemah soils.

Dennis silt loam, 1 to 3 percent slopes (DnB).—This very gently sloping soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping, and making up 10 percent of the acreage, is a soil that is similar to this soil but has a combined surface layer and subsoil less than 60 inches in thickness. Also, included areas of Choteau soils make up 4 percent of the acreage; Parsons soils, 3 percent; Taloka soils, 5 percent; and Bates soils, 2 percent.

Areas of this soil are used for small grain, grain sorghum, soybeans, corn, alfalfa, tame pasture, and range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Dennis silt loam, 3 to 5 percent slopes (DnC).—This gently sloping soil is on uplands. This soil is steeper, but it has a profile similar to the one described as representative of the series.

Included with this soil in mapping, and making up about 10 percent of the acreage, are areas of a soil that is similar to Dennis soils but has a combined surface layer and subsoil less than 60 inches in thickness. Also, included areas of Choteau soils make up 13 percent of the acreage; Bates soils, 10 percent; and Coweta soils, 7 percent.

Areas of this soil are used for small grain, grain sorghum, soybeans, tame pasture, and range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Dennis silt loam, 2 to 5 percent slopes, eroded (DnC2).—This moderately eroded, very gently sloping to gently sloping soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer has been thinned by erosion. A few places have rills and gullies ranging in depth from 1 to 4 feet. The surface layer and part of the subsoil have been mixed by cultivation in about 20 percent of the areas.

Included with this soil in mapping, and making up about 8 percent of the acreage, is a soil that is similar to Dennis soils, but the combined thickness of the surface layer and subsoil is less than 60 inches. Also, Bates soils make up 6 percent of the acreage; Okemah soils, 4 percent; and Coweta soils, 3 percent.

Areas of this soil are used for small grain, grain sorghum, soybeans, and tame pasture. These soils are not generally suited to row crops.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-3; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Dennis-Radley complex, 0 to 15 percent slopes (DxE).—These nearly level to moderately steep soils are on uplands and flood plains. Both Dennis and Radley soils have profiles similar to the ones described as representative of their respective series.

Dennis silt loam occupies the very gently sloping to gently sloping uplands and makes up about 41 percent of this complex. Radley silt loam is nearly level and occupies flood plains and makes up about 28 percent of the acreage.

Included with these soils in mapping, and each making up 5 percent of the acreage, are areas of a soil that is similar to Radley silt loam but has a thinner surface layer and less clayey underlying material and areas of a soil that is similar to Dennis silt loam but has a surface layer and subsoil combined less than 60 inches in thickness. These areas are on sloping to moderately steep side slopes. In addition, included areas of Taloka silt loam make up 11 percent of the acreage; Coweta loam, 5 percent; Parsons silt loam, 3 percent; and Okemah silt loam, 2 percent.

Areas of these soils are not suited to cultivated crops because of frequent flooding and excessive slope. They are used mainly for range, wildlife habitat, or trees.

Management is needed that maintains or improves stands of desirable grasses or trees. The control of brush and undesirable vegetation requires proper grazing practices and prevention of burning. Capability unit VIe-1; tree suitability group 8; Dennis soils in Loamy Prairie range site and pasture and hayland suitability group 8A; Radley soils in Loamy Bottomland range site and pasture and hayland suitability group 2A.

Enders Series

The Enders series consists of deep, sloping to steep soils on uplands. These soils formed under a cover of hardwood forest and an understory of native grasses in material weathered from shale.

In a representative profile the surface layer is 5 inches of dark-brown gravelly fine sandy loam and loam. The upper part of the subsoil, extending to a depth of 18 inches, is yellowish-red silty clay. Below this, to a depth of 28 inches, is red clay. The lower part, extending to a depth of 38 inches, is mottled, gray, yellowish-brown, grayish-brown, red, and yellowish-red silty clay. The underlying material is light-gray weathered soft shale.

Enders soils are well drained and are very slowly permeable. Available water capacity is high.

Representative profile of Enders gravelly fine sandy loam, in an area of Hector-Enders complex, 5 to 30 percent slopes, 1,800 feet west of the northeast corner of sec. 5, T. 18 N., R. 19 E.:

A11—0 to 2 inches, dark-brown (10YR 3/3) gravelly fine sandy loam, brown (10YR 5/3) dry; weak, fine, granular structure; very friable; common fine roots; common sandstone fragments; strongly acid; gradual, smooth boundary.

A12—2 to 5 inches, dark-brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; weak, fine, granular structure; friable; common fine roots; common shale and sandstone fragments; strongly acid; gradual, smooth boundary.

B1—5 to 11 inches, dark-brown (7.5YR 4/4) clay loam, light brown (7.5YR 6/4) dry; weak, fine, subangular blocky structure; friable; few fine roots; common sandstone and shale fragments; strongly acid; clear, smooth boundary.

B21t—11 to 18 inches, yellowish-red (5YR 4/6) silty clay, yellowish red (5YR 5/6) dry; moderate, fine, blocky structure; firm; few fine roots; thick continuous clay films; few sandstone and shale fragments; very strongly acid; gradual, smooth boundary.

B22t—18 to 28 inches, red (2.5YR 4/8) clay; common, medium, distinct, brown (7.5YR 5/4) and grayish-brown (10YR 5/2) mottles; strong, coarse, blocky structure; extremely firm; few fine roots; thick, continuous clay films; few, fine, shale fragments; very strongly acid; gradual, smooth boundary.

B3—28 to 38 inches, mottled gray (10YR 6/1), yellowish-brown (10YR 5/4), grayish-brown (10YR 5/2), red (2.5YR 4/6), and yellowish-red (5YR 4/6) silty clay; strong, fine, subangular blocky structure; firm, hard; few fine roots; thin, patchy clay films; common fine shale fragments; extremely acid; gradual, smooth boundary.

C—38 to 44 inches, light-gray (5Y 7/1) weathered soft shale; common, coarse, prominent, red (2.5YR 4/6) mottles; very strongly acid.

The solum ranges from 32 to 58 inches in thickness. It is strongly acid to extremely acid throughout. The A horizon and B2 horizon are 2 to 15 percent coarse fragments by volume, and the B3 horizon is 15 to 40 percent. Depth to hard rock is 40 to 60 inches.

The A11 horizon is dark brown or very dark grayish brown, and the A12 horizon is dark brown, brown, or dark yellowish brown.

The B1 horizon is dark-brown, brown, strong-brown, dark yellowish-brown, or yellowish-brown clay loam, silty clay loam, or loam. The B2t horizon is yellowish-red or red silty clay or clay. It has mottles in shades of gray or brown in the lower part. The B3 horizon has mottles in shades of red, brown, and gray. It is silty clay or clay.

The C horizon is strongly acid to extremely acid. It has mottles in shades of red or brown.

Enders soils are associated with Hector and Linker soils. They are deeper to bedrock and have a more clayey B horizon than Hector soils, and they have a Bt horizon, that Hector soils lack. Enders soils are more clayey in the B2t horizon than Linker soils.

Enders soils, in this survey area, occur only as part of the Hector-Enders complex, 5 to 30 percent slopes.

Hector Series

The Hector series consists of shallow, very gently sloping to very steep soils on uplands. These soils formed under a cover of hardwood forest and an understory of native grasses in material weathered from sandstone.

In a representative profile the surface layer is about 2 inches of dark-brown gravelly fine sandy loam. The subsurface layer is about 4 inches of dark yellowish-brown gravelly fine sandy loam. The subsoil is strong-brown gravelly fine sandy loam about 10 inches thick. Hard massive sandstone is at a depth of 16 inches.

Hector soils are well drained and are moderately rapidly permeable. Available water capacity is low.

Representative profile of Hector gravelly fine sandy loam, in an area of Hector-Enders complex, 5 to 30 percent slopes, 1,400 feet east of the northeast corner of sec. 5, T. 18 N., R. 19 E.:

A1—0 to 2 inches, dark-brown (10YR 3/3) gravelly fine sandy loam, brown (10YR 5/3) dry; weak, fine, granular structure; very friable; many medium roots; common sandstone fragments; strongly acid; gradual, smooth boundary.

A2—2 to 6 inches, dark yellowish-brown (10YR 4/4) gravelly fine sandy loam, light yellowish brown (10YR 6/4) dry; fine, granular structure; friable; common medium roots; common sandstone fragments; slightly acid; gradual, smooth boundary.

B2—6 to 16 inches, strong-brown (7.5YR 5/6) gravelly fine sandy loam, yellow (10YR 7/6) dry; weak, medium, subangular blocky structure; friable; common medium roots; common sandstone fragments; very strongly acid; abrupt, irregular boundary.

R—16 inches, hard, massive, sandstone bedrock.

The A1 horizon is dark grayish-brown, very dark grayish-brown, dark-brown, or brown fine sandy loam or gravelly fine sandy loam. It is slightly acid to strongly acid. This horizon is 0 to 25 percent sandstone fragments.

The A2 horizon is brown, dark-brown, yellowish-brown, or dark yellowish-brown fine sandy loam or gravelly fine sandy loam. It is slightly acid to strongly acid. This horizon is 0 to 25 percent sandstone fragments.

The B2 horizon is strong-brown, yellowish-red, or yellowish-brown fine sandy loam or gravelly fine sandy loam. It is strongly acid or very strongly acid. This horizon is 0 to 25 percent sandstone fragments.

Sandstone bedrock is at a depth of 10 to 20 inches.

Hector-Enders complex, 5 to 30 percent slopes (HeF).—These sloping to steep soils are on uplands. Both Hector and Enders soils have the profiles described as representative of their respective series.

Hector gravelly fine sandy loam makes up about 45 percent of this complex. Enders gravelly fine sandy loam makes up 38 percent.

Included with these soils in mapping, and making up 5 percent of the acreage, is a soil that is similar to the Hector soil in this complex but has bedrock at a depth of less than 8 inches. Also included is a soil similar to the Hector soil but is dark brown throughout. Included areas of Linker fine sandy loam make up 7 percent of the acreage.

Most areas of these soils are woodland and are used for grazing or wildlife habitat.

Management is needed that maintains or improves stands of desirable grasses or trees through proper grazing and prevention of burning. Capability unit VIIs-2; Hector soils in Shallow Savannah range site, Enders soils in Sandy Savannah range site; not assigned to pasture and hayland suitability group; tree suitability group 6.

Hector-Linker complex, 1 to 5 percent slopes (HrC).—These very gently sloping or gently sloping soils are on uplands. Both Hector and Linker soils have profiles similar to the ones described as representative of their respective series.

Hector gravelly fine sandy loam makes up about 40 percent of this complex. Linker fine sandy loam makes up 35 percent of the acreage.

Included with these soils in mapping, and making up 10 percent of the acreage, is a soil that is similar to the Hector soil in this complex but is less than 8 inches deep to sandstone. Included areas of Enders gravelly fine sandy loam make up 7 percent of the acreage; Bates fine sandy loam, 5 percent; and Coweta loam, 3 percent.

Most areas of these soils are wooded and are used for grazing. Some areas have been cleared and are used for small grain, grain sorghum, or tame pasture plants.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Where crops are sown, residue left on the surface helps to prevent erosion. Other helpful practices are fertilization, minimum tillage or no tillage, and brush control. Tame pasture is a common use of these soils. Capability unit IVe-1; tree suitability group 6; Hector soils in Shallow Savannah range site, Linker soils in Sandy Savannah range site; Hector soils in pasture and hayland suitability group 14A, Linker soils in pasture and hayland suitability group 8B.

Hector soils, 20 to 50 percent slopes (HsF).—These steep or very steep soils are on uplands. The texture of the surface layer ranges from gravelly fine sandy loam to fine sandy loam, but otherwise these soils have a profile similar to the one described as representative of the Hector series.

Included with these soils in mapping, and making up about 8 percent of the acreage, is a soil that is similar to Hector soils but has sandstone bedrock at a depth of less than 10 inches. A soil that is similar to Hector soils but has sandstone at a depth of 20 to 40 inches makes up about 11 percent of the acreage. Included areas of Enders soils make up about 6 percent of the acreage, and spots of Rock outcrop, 20 percent.

Most areas of this soil are wooded and are used for grazing and wildlife habitat.

Management is needed that maintains or improves stands of desirable grasses and trees. Proper grazing practices and prevention of fire help to control brush and undesirable vegetation. Capability unit VIIs-2; Savannah Breaks range site; not assigned to pasture and hayland suitability group; tree suitability group 6.

Kamie Series

The Kamie series consists of deep, very gently sloping to moderately steep soils on uplands. These soils formed under a cover of hardwood forest and an understory of native grasses in loamy and sandy sediment.

In a representative profile the surface layer is 6 inches of brown fine sandy loam. The subsurface layer is 12 inches of brown fine sandy loam. The upper part of the subsoil, extending to a depth of 42 inches, is dark-red sandy clay loam. The middle part, to a depth of 56 inches, is yellowish-red sandy clay loam. The lower part, extending to a depth of 70 inches, is reddish-yellow fine sandy loam, red sandy clay loam, and pockets of clean sand grains.

Kamie soils are well drained and are moderately permeable. Available water capacity is moderate.

Representative profile of Kamie fine sandy loam, 1 to 5 percent slopes, 1,000 feet west and 100 feet south of the northeast corner of sec. 26, T. 17 N., R. 15 E.:

Ap—0 to 6 inches, brown (10YR 4/3) fine sandy loam; weak, fine, granular structure; very friable; common roots; medium acid; clear, smooth boundary.

A2—6 to 18 inches, brown (7.5YR 5/4) fine sandy loam; weak, fine, granular structure; very friable; few roots; medium acid; clear, smooth boundary.

B21t—18 to 42 inches, dark-red (2.5YR 3/6) sandy clay loam; moderate, medium, subangular blocky structure; firm; few patchy clay films on ped surfaces and bridging sand grains; strongly acid; diffuse, smooth boundary.

B22t—42 to 56 inches, yellowish-red (5YR 4/8) sandy clay loam; moderate, medium, subangular blocky structure; firm; few patchy clay films on ped surfaces and bridging sand grains; medium acid; diffuse, wavy boundary.

B3t—56 to 70 inches, about 75 percent by volume reddish-yellow (5YR 6/6) fine sandy loam and about 21 percent by volume red (2.5YR 4/6) sandy clay loam in a mixed pattern; weak, medium, subangular blocky structure; very friable; thin patchy clay films on ped surfaces and bridging sand grains; about 4 percent by volume skeletons or pockets of clean sand grains; strongly acid.

The A horizon is fine sandy loam or loamy fine sand. It is neutral to medium acid. The Ap or A1 horizon is brown or dark grayish brown. The A2 horizon is brown, dark yellowish brown, yellowish brown, or strong brown.

The B21t horizon is yellowish-red, dark-red, or red sandy clay loam or clay loam. It is medium acid or strongly acid. The B22t horizon is reddish-brown, yellowish-red, or red sandy clay loam or clay loam. It is medium acid to very strongly acid. The B3t horizon is yellowish-red, reddish-yellow, red, or light-red fine sandy loam or sandy clay loam. It is medium acid to very strongly acid. This horizon has pockets of clean sand grains that make up 1 to 4 percent of the volume.

Kamie soils are associated with Okay soils. They have a more sandy A horizon than Okay soils and have an A2 horizon, which Okay soils lack.

Kamie loamy fine sand, 5 to 20 percent slopes (KaE).—This sloping to moderately steep soil is on uplands. It has a profile similar to that described as representative of the series, except the surface layer and subsurface layer are loamy fine sand and together are about 4 inches thicker.

Included with this soil in mapping, and making up 20 percent of the acreage, is a deep sandy soil that has a discontinuous subsoil. Included areas of Kamie fine sandy loam make up 10 percent of the acreage, and gullies, 3 percent.

Most areas of these soils are used for tame pasture plants or woodland-pasture plants.

Management is needed that maintains or improves fertility and encourages stands of desirable grasses and trees that provide protective cover. The control of brush and undesirable vegetation requires proper grazing and prevention of burning. Capability unit VIe-2; Sandy Savannah range site; pasture and hayland suitability group 9A; tree suitability group 5.

Kamie fine sandy loam, 1 to 5 percent slopes (KfC).—This very gently sloping or gently sloping soil is on uplands. It has the profile described as representative of the series (fig. 6).

Included with this soil in mapping, and making up about 16 percent of the acreage, is a soil that is similar to this Kamie soil but is sandier throughout the surface

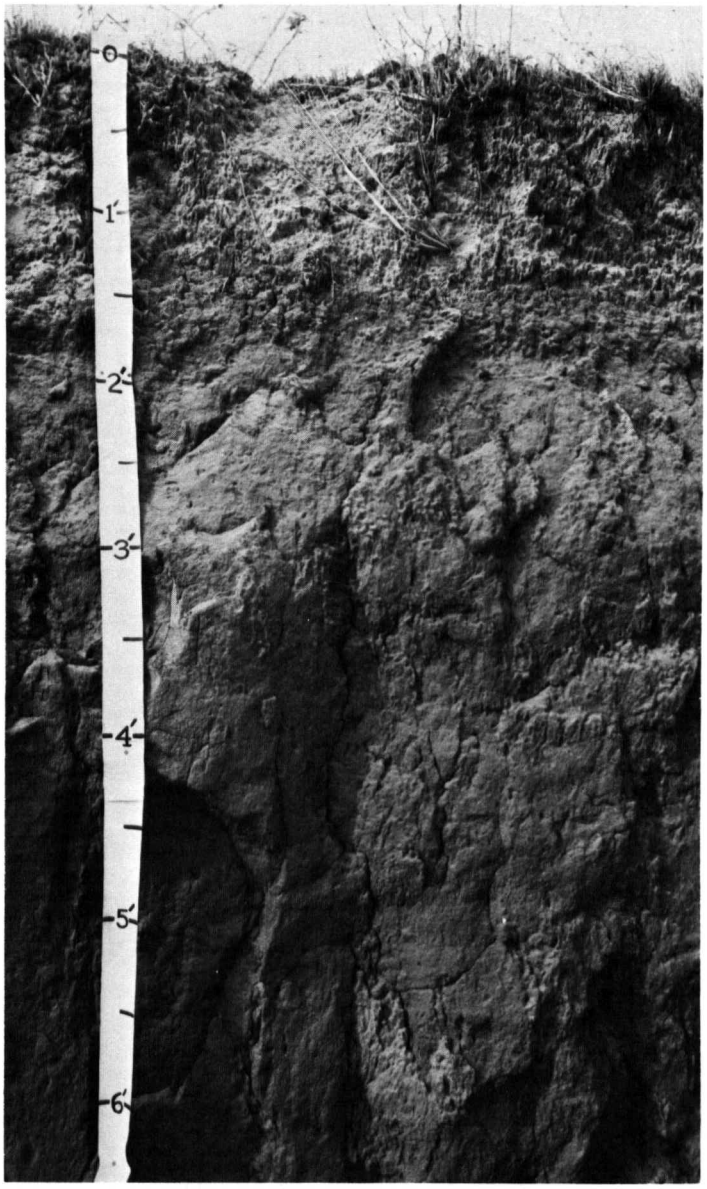

Figure 6.—**Profile of Kamie fine sandy loam showing the sandy clay loam subsoil beginning at a depth of about 18 inches and continuing to a depth of more than 6 feet.**

layer and subsoil. Included areas of Okay soils make up 6 percent of the acreage.

Areas of this soil are used for small grain, soybeans, grain sorghum, and tame pasture plants.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-1; Sandy Savannah range site; pasture and hayland suitability group 8A; tree suitability group 5.

Kamie fine sandy loam, 2 to 5 percent slopes, eroded (KfC2).—This moderately eroded, very gently sloping or gently sloping soil is on uplands. It has a profile similar to that described as representative of the series, except the surface layer has been thinned by erosion. In places are rills and gullies ranging in depth from 6 to 48 inches. The surface layer and the upper part of the subsoil have been mixed by cultivation in about 20 percent of the area.

Included with this soil in mapping, and making up about 10 percent of the acreage, is a soil that is similar to this Kamie soil but has a surface layer and a subsurface layer of loamy fine sand. Included areas of Okay soils make up 4 percent of the acreage, and gullies, 5 percent.

Areas of this soil are used for small grain, grain sorghum, and tame pasture plants.

Management is needed that maintains or improves soil structure and fertility and that controls erosion. Row crops are not suited to this soil. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-3; Sandy Savannah range site; pasture and hayland suitability group 8A; tree suitability group 5.

Kamie soils, 2 to 8 percent slopes, severely eroded (KmD3).—These severely eroded, very gently sloping to sloping soils are on uplands. They have profiles similar to the one described as representative of the series, except part or all of the surface layer has been removed by erosion in about 70 percent of the area and its texture ranges from fine sandy loam to loamy fine sand. About 10 percent of the area is uncrossable gullies that are as deep as 15 feet and occur at intervals of 25 to 150 feet.

Included with these soils in mapping, and making up about 15 percent of the acreage, is a soil that is similar to these Kamie soils but has a discontinuous subsoil. Included spots of Okay soils make up 5 percent of the acreage.

Areas of these soils are used mainly for tame pasture plants or are idle.

Management is needed that establishes and maintains stands of grasses or trees and controls erosion. Practices needed in places are management of residue, fertilization, use of diversion terraces, gully control, and establishment of grass cover. Capability unit VIe-3; Eroded Sandy Savannah range site; pasture and hayland suitability group 9A; tree suitability group 5.

Kanima Series

The Kanima series consists of deep, gently sloping to very steep soils on uplands. These soils formed under a cover of tame or native grass or hardwood trees in material weathered from shale that was displaced in strip-mining operations.

In a representative profile the surface layer is 4 inches of dark-brown shaly silty clay loam. The underlying material is brown very shaly silty clay loam.

Kanima soils are well drained and are moderately permeable. Available water capacity is low.

Representative profile of Kanima shaly silty clay loam in an area of Kanima soils, 3 to 50 percent slopes, 1,000 feet west and 100 feet north of the southeast corner of sec. 9, T. 19 N., R. 15 E.:

A1—0 to 4 inches, dark-brown (10YR 4/3) shaly silty clay loam; weak, fine, granular structure; friable, hard; common fine roots; 15 percent shale fragments; slightly acid; clear, wavy boundary.

C—4 to 72 inches, brown (10YR 5/3) very shaly silty clay loam; massive; 60 percent light-gray (10YR 6/1) and yellowish-brown (10YR 5/6) shale fragments; few fragments of very dark grayish-brown (10YR 3/2) silt loam and yellowish-brown (10YR 5/4) silty clay loam, that has thin, patchy clay films; neutral.

The A1 horizon is dark grayish-brown, very dark grayish-brown, or dark-brown shaly silty clay loam or very shaly clay loam. It is medium acid to moderately alkaline. Shale fragments less than 3 inches in diameter make up 15 to 30 percent of the volume of this horizon and shale fragments larger than 3 inches in diameter make up less than 5 percent.

The C horizon is very dark grayish brown, dark grayish brown, or brown. It is medium acid to moderately alkaline. Shale fragments less than 3 inches in diameter make up 50 to 90 percent of the volume of this horizon, and shale fragments larger than 3 inches in diameter make up 5 to 30 percent. Fragments or pockets of soil material with higher chroma are present in places.

Kanima soils are associated with Dennis and Okemah soils. Unlike these soils, Kanima soils are more than 35 percent shale fragments at depths below the A horizon, and they lack a Bt horizon, which is present in both Dennis and Okemah soils.

Kanima soils, 3 to 50 percent slopes (KnF).—These gently sloping to very steep soils are on uplands. They have the profile described as representative of the series, except the texture of the surface layer ranges from shaly silty clay loam to shaly clay loam.

Included with these soils in mapping, and making up about 20 percent of the acreage, is a soil that is similar to these Kanima soils but lack fragments of dark-colored material in the underlying material. Included areas of strip pits that are generally filled with water make up about 3 percent of the acreage.

Kanima soils are poorly suited to tame pasture plants, native grass, range, and trees. They are well suited to wildlife habitat (fig. 7).

Management is needed that establishes or improves and maintains stands of vegetative cover. Practices needed in places are leveling, establishing desired vegetative cover, control grazing, and fertilization. Capability unit VIIs-3; not assigned to a range site; not assigned to a pasture and hayland suitability group; tree suitability group 9.

Kiomatia Series

The Kiomatia series consists of deep, nearly level soils on flood plains. These soils formed under a cover

Figure 7.—**Wildlife cover and grasses on an area of Kanima soils, 3 to 50 percent slopes.**

of mixed forest in sandy sediment that has thin strata of finer material.

In a representative profile the surface layer is 18 inches of brown fine sandy loam. The upper part of the underlying material, extending to a depth of 48 inches, is reddish-brown loamy fine sand. The lower part is reddish-brown loamy sand.

Kiomatia soils are well drained and are rapidly permeable. Available water capacity is low.

Representative profile of Kiomatia fine sandy loam, 1,400 feet west and 500 feet south of the northeast corner of sec. 36, T. 17 N., R. 15 E.:

A1—0 to 18 inches, brown (7.5YR 4/4) fine sandy loam; moderate, fine, granular structure; friable; thin strata of very fine sandy loam; slightly acid; gradual, smooth boundary.

C1—18 to 48 inches, reddish-brown (5YR 4/4) loamy fine sand; massive; very friable; thin strata of fine sandy loam; neutral; gradual, smooth boundary.

C2—48 to 56 inches, reddish-brown (5YR 5/4) loamy sand; single grained; loose; thin strata of very fine sandy loam and fine sandy loam; mildly alkaline.

The A1 horizon is brown or strong brown.

The C1 horizon is reddish-brown, light reddish-brown, pink, brown, light-brown, or strong-brown loamy fine sand or fine sand that is stratified with loamy fine sand or finer material. It is slightly acid or mildly alkaline.

The C2 horizon is reddish-brown, light reddish-brown, pink, brown, light-brown, or strong-brown loamy fine sand. It has thin strata of very fine sandy loam and fine sandy loam. This horizon is slightly acid or mildly alkaline.

Kiomatia soils are associated with Choska and Tullahassee soils. They have an average texture of fine sand or loamy sand between depths of 10 and 40 inches, but both Choska and Tullahassee soils are finer textured. In addition, Kiomatia soils lack the dark-brown A horizon more than 7 inches thick of Choska soils. They lack the mottles indicating wetness at a depth of less than 20 inches that are present in Tullahassee soils.

Kiomatia fine sandy loam (Ko).—This nearly level soil is on flood plains (fig. 8). It is subject to occasional flooding of brief duration during wet periods.

Included with this soil in mapping, and making up 5 percent of the acreage, is a soil that is similar to this Kiomatia soil but lacks the stratification with finer material below the surface layer. Included areas of Choska soils make up 20 percent of the acreage and Mason soils, 10 percent.

Areas of these soils are used for small grain, grain sorghum, and tame pasture plants.

Management is needed that maintains or improves

Figure 8.—**Area of Kiomatia fine sandy loam showing the effects of soil blowing and sand movement in freshly worked field.**

soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, and minimum tillage or no tillage. Capability unit IIIs-1; Sandy Bottomland range site; pasture and hayland suitability group 3A; tree suitability group 3.

Latanier Series

The Latanier series consists of deep, nearly level soils on flood plains. These soils formed in clayey and loamy sediment under a cover of hardwood forest with an understory of native grasses.

In a representative profile the surface layer is 8 inches of dark reddish-brown clay. The subsoil, extending to a depth of 24 inches, is dark reddish-brown clay. The upper part of the underlying material, extending to a depth of 32 inches, is reddish-brown silt loam. The middle part, to a depth of 42 inches, is reddish-brown very fine sandy loam. The lower part, extending to a depth of 64 inches, is brown very fine sandy loam.

Latanier soils are somewhat poorly drained and are very slowly permeable. Available water capacity is high.

Representative profile of Latanier clay, 1,320 feet west and 200 feet north of the southeast corner of sec. 5, T. 16 N., R. 16 E.:

A1—0 to 8 inches, dark reddish-brown (5YR 3/3) clay; strong, medium, subangular blocky structure; very firm; neutral; gradual, wavy boundary.

B2—8 to 24 inches, dark reddish-brown (5YR 3/3) clay; moderate, medium, angular blocky structure; very firm; few carbonate spots and veins that are calcareous; moderately alkaline; abrupt, wavy boundary.

IIC1—24 to 32 inches, reddish-brown (5YR 4/4) silt loam; massive; friable; common fine carbonate spots that are calcareous; moderately alkaline; clear, wavy boundary.

IIC2—32 to 42 inches, reddish-brown (5YR 5/4) very fine sandy loam; massive; friable; common fine carbonate spots that are calcareous; moderately alkaline; clear, wavy boundary.

IIC3—42 to 64 inches, brown (7.5YR 5/4) very fine sandy loam; massive; very friable; soft; moderately alkaline; calcareous.

The A1 horizon is dark brown or dark reddish brown. This horizon cracks when dry.

The B2 horizon is dark red to reddish brown. It is neutral to moderately alkaline and is calcareous.

The IIC1 horizon is reddish-brown, dark reddish-brown, yellowish-red, or strong-brown silt loam or very fine sandy loam. It is neutral to moderately alkaline.

The IIC2 horizon is reddish-brown, dark reddish-brown, strong-brown, or yellowish-red stratified very fine sandy loam or silt loam.

The IIC3 horizon is yellowish-red, reddish-brown, dark-brown, or strong-brown silt loam or very fine sandy loam.

Latanier soils are associated with Mason and Moreland soils. They lack the B2t horizon of Mason soils. In Latanier soils hues are 5YR or redder in the B horizon, but in Mason soils they are 7.5YR or yellower in this horizon. Latanier soils are loamy below a depth of 20 to 36 inches, but Moreland soils are not.

Latanier clay (La).—This nearly level soil is on flood plains. It is subject to occasional flooding of brief duration during wet periods.

Included with this soil in mapping are about 11 percent Moreland soils, 5 percent Mason soils, and 4 percent Choska soils.

Figure 9.—**Wheat growing on Latanier clay.**

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, alfalfa, and tame pasture plants (fig. 9).

Management is needed that maintains or improves soil structure and fertility. Practices needed in places are management of crop residue, fertilization, minimum tillage, control of flooding, and arrangement of rows for drainage. Capability unit IIIw-2; Heavy Bottomland range site; pasture and hayland suitability group 1A; tree suitability group 4.

Linker Series

The Linker series consists of moderately deep, very gently sloping or gently sloping soils on uplands. These soils formed in material weathered from sandstone under a cover of hardwood and pine forest and an understory of native grasses.

In a representative profile the surface and subsurface layers are 13 inches of dark grayish-brown or brown fine sandy loam. The upper part of the subsoil, extending to a depth of 16 inches, is strong-brown sandy clay loam. The middle part, to a depth of 28 inches, is yellowish-red sandy clay loam. The lower part, extending to a depth of 34 inches, is strong-brown sandy loam. The underlying material, extending to a depth of

40 inches, is mottled, yellowish-red, strong-brown, and light-gray weathered sandstone. Hard sandstone is at a depth of 40 inches.

Linker soils are well drained and are moderately permeable. Available water capacity is moderate.

Representative profile of Linker fine sandy loam, 1 to 3 percent slopes, 2,000 feet south and 100 feet east of the northwest corner of sec. 6, T. 18 N., R. 16 E.:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) fine sandy loam; weak, fine, granular structure; friable, soft; few medium roots; strongly acid; clear, smooth boundary.

A2—3 to 13 inches, brown (10YR 5/3) fine sandy loam; weak, very fine, granular structure; few medium roots; strongly acid; clear, smooth boundary.

B1—13 to 16 inches, strong-brown (7.5YR 5/6) sandy clay loam; common, fine, distinct, yellowish-red mottles; moderate, fine, subangular blocky structure; friable; few medium roots; strongly acid; gradual, smooth boundary.

B2t—16 to 28 inches, yellowish-red (5YR 5/6) sandy clay loam; common, fine, distinct, red mottles; moderate, medium, subangular blocky structure; firm; very hard; few medium roots; few medium pores; thin, patchy clay films on ped surfaces; very strongly acid; gradual, smooth boundary.

B3—28 to 34 inches, strong-brown (7.5YR 5/6) sandy loam; strong brown (7.5YR 5/8) dry; common, medium, prominent, dark-red (2.5YR 3/6) mottles; weak, medium, subangular blocky structure; firm; hard; common, fine, soft sandstone fragments; extremely acid; clear, wavy boundary.

C—34 to 40 inches, yellowish-red (5YR 5/8), strong-brown (7.5YR 5/8) and light-gray (10YR 7/1) soft weathered sandstone; very strongly acid.

R—40 inches, hard acid sandstone.

Thickness of the solum and depth to bedrock are 20 to 40 inches. This soil is extremely acid to strongly acid throughout.

The A1 horizon is dark brown, dark grayish brown, brown, or very dark grayish brown. The A2 horizon is brown, grayish brown, or yellowish brown.

The B1 horizon is reddish-brown, brown, yellowish-red, strong-brown, reddish-yellow, light-brown, or light reddish-brown fine sandy loam or sandy clay loam. The B2t horizon is reddish-brown, yellowish-red, or red sandy clay loam or clay loam. The B3 horizon is mottled, red or brown, sandy loam or sandy clay loam. It has few to many small sandstone fragments.

These soils are outside the defined range for the Linker series in that they have reddish mottles in the upper part of the B horizon. They are enough like the Linker soils in morphology, composition, and behavior that a new series is not warranted.

Linker soils are associated with Enders and Hector soils. They differ from Enders soils in having bedrock within a depth of 40 inches and having less clay in the Bt horizon. Linker soils differ from Hector soils by being more than 20 inches deep to bedrock.

Linker fine sandy loam, 1 to 3 percent slopes (LnB).—This very gently sloping soil is on uplands.

Included with this soil in mapping, and making up about 23 percent of the acreage, is a soil that is similar to this Linker soil except the finer textured part of the subsoil has an average clay content of more than 35 percent. Included areas of Bates soils make up 10 percent of the acreage; Hector soils, 8 percent; Rock outcrop, 3 percent; and a soil that is similar to this Linker soil but has bedrock at a depth of more than 40 inches, 3 percent.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, tame pasture plants, or woodland range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terraces, contour farming, and minimum tillage or no tillage. Capability unit IIe-2; Sandy Savannah range site; pasture and hayland suitability group 8B; tree suitability group 5.

Lula Series

The Lula series consists of deep, very gently sloping soils on uplands. These soils formed under a cover of native grasses in loamy residuum from limestone.

In a representative profile the surface layer is 10 inches of very dark brown silt loam. The upper part of the subsoil, extending to a depth of 18 inches, is dark-brown silt loam. The middle part, to a depth of 38 inches, is dark-brown silty clay loam. The lower part, extending to a depth of 52 inches, is reddish-brown silty clay loam. Hard limestone bedrock is at a depth of 52 inches.

Lula soils are well drained and are moderately permeable. Available water capacity is high.

Representative profile of Lula silt loam, 1 to 3 percent slopes, 1,200 feet west and 600 feet south of the northeast corner of sec. 6 T. 19 N., R. 15 E.:

A1—0 to 10 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; strong, medium, granular structure; friable; hard; slightly acid; gradual, smooth boundary.

B1—10 to 18 inches, dark-brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; strong, medium, granular structure; friable; hard; medium acid; gradual, smooth boundary.

B21t—18 to 38 inches, dark-brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; moderate, medium, blocky structure; firm, hard; clay films on ped surfaces; few black concretions; slightly acid; gradual, smooth boundary.

B22t—38 to 46 inches, reddish-brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) dry; common, fine, prominent, dark-brown mottles; moderate, medium, blocky structure; firm, hard; clay films on ped surfaces; many black concretions; neutral; gradual, smooth boundary.

B23t—46 to 52 inches, reddish-brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) dry; weak, medium, blocky structure; firm; very hard; clay films on ped surfaces; many black concretions; neutral; abrupt, wavy boundary.

R—52 inches, hard limestone bedrock.

The A1 horizon is dark reddish brown, very dark brown, dark brown, or very dark grayish brown. It is slightly acid or medium acid.

The B1 horizon is dark-brown, dark yellowish-brown, brown, dark reddish-brown, or reddish-brown silt loam, clay loam, or silty clay loam. It is slightly acid or medium acid.

The B21t horizon is dark reddish-brown, reddish-brown, brown, or dark-brown clay loam or silty clay loam. It is slightly acid to strongly acid.

The B22t horizon is brown, dark-brown, dark reddish-brown, dark-red, yellowish-red, or reddish-brown clay loam or silty clay loam. It is neutral to medium acid.

The B23t horizon is brown, dark-brown, red, reddish-brown, dark-red, or yellowish-red clay loam or silty clay loam. It is neutral to medium acid.

Limestone bedrock is at a depth of 40 to 60 inches.

Lula soils are associated with Catoosa, Newtonia, and Summit soils. They have bedrock at a depth of 40 to 60 inches, unlike Catoosa soils, which have bedrock at a depth of 20 to 40 inches and Newtonia soils, which lack bedrock

within a depth of 60 inches. Unlike Summit soils, Lula soils are less than 35 percent clay in the upper part of the B2t horizon, and they do not crack on the surface in dry years as do Summit soils.

Lula silt loam, 1 to 3 percent slopes (LuB).—This gently sloping soil is on uplands.

Included with this soil in mapping are about 10 percent Catoosa soils, 8 percent Dennis soils, 4 percent Summit soils, 2 percent Newtonia soils, and 2 percent Okemah soils.

Areas of this soil are used for small grain, grain sorghum, soybeans, corn, alfalfa, tame pasture plants, and range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 7.

Mason Series

The Mason series consists of deep, nearly level soils on low terraces. These soils formed under a cover of hardwood forest and an understory of native grasses in loamy sediment.

In a representative profile the surface layer is 8 inches of very dark grayish-brown silt loam. The next layer, extending to a depth of 22 inches, is very dark grayish-brown silt loam. The upper part of the subsoil, extending to a depth of 34 inches, is dark-brown silt loam. The lower part, to a depth of 52 inches, is dark-brown clay loam. The underlying material, to a depth of 60 inches, is brown loam.

Mason soils are well drained and are moderately slowly permeable. Available water capacity is high.

Representative profile of Mason silt loam, 500 feet west and 100 feet north of the southeast corner of sec. 4, T. 16 N., R. 16 E.:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate, medium, granular structure; friable, slightly hard; neutral; clear, smooth boundary.

A1—8 to 22 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate, medium, granular structure; friable, hard; neutral; gradual, smooth boundary.

B2t—22 to 34 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; moderate, medium, subangular blocky structure; firm, very hard; slightly acid; gradual, smooth boundary.

B3—34 to 52 inches, dark-brown (7.5YR 3/2) clay loam, brown (7.5YR 5/4) dry; weak, fine, subangular blocky structure; firm, very hard; slightly acid; gradual, smooth boundary.

C—52 to 60 inches, brown (7.5YR 4/4) loam, light brown (7.5YR 6/4) dry; weak, fine, subangular blocky structure; very firm, very hard; pockets and strata of clean sand grains; mildly alkaline.

The A horizon is very dark brown or very dark grayish brown.

The B2t horizon is dark brown, brown, very dark grayish brown, dark yellowish brown, or dark grayish brown. It is slightly acid or medium acid.

The B3 horizon is dark brown, very dark grayish brown, brown, dark yellowish brown, or dark grayish brown. It is medium acid or slightly acid. This horizon has mottles in shades of brown, gray, or red.

The C horizon has mottles in shades of brown, gray, or red. It is loam or clay loam. This horizon is medium acid to mildly alkaline.

Mason soils are associated with Choska, Latanier, and Radley soils. They have a B2t horizon that all of those soils lack.

Mason silt loam (Ma).—This nearly level soil is on terraces.

Included with this soil in mapping, and making up about 35 percent of the acreage, is a soil that is similar to Mason soil except in the upper part of the subsoil it is less than 18 percent clay. Included areas of a soil that is similar to this Mason soil but has wetness mottles in the upper 20 inches of the subsoil make up 8 percent of the acreage, and Latanier soils, 5 percent.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, cotton, alfalfa, truck crops, and tame pasture plants.

Management is needed that maintains or improves soil structure and fertility. Practices needed in places are management of crop residue, fertilization, and minimum tillage. Capability unit I-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 1.

Moreland Series

The Moreland series consists of deep, nearly level soils on flood plains. These soils formed in clayey sediment under a cover of hardwood forest and an understory of native grasses.

In a representative profile the surface layer is 6 inches of dark reddish-brown clay. The subsoil, extending to a depth of 56 inches, is dark reddish-brown clay.

Moreland soils are somewhat poorly drained and are very slowly permeable. Available water capacity is high.

Representative profile of Moreland clay, 330 feet west and 100 feet south of the northeast corner of sec. 8, T. 16 N., R. 16 E.:

Ap—0 to 6 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/3) dry; strong, fine, granular structure; firm, hard; neutral; clear, smooth boundary.

B21—6 to 18 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/3) dry; moderate, medium, subangular blocky structure; firm, hard; moderately alkaline; gradual, wavy boundary.

B22—18 to 30 inches, dark reddish-brown (5YR 3/4) clay, reddish brown (5YR 5/4) dry; few, fine, dark-gray mottles; weak, medium, subangular blocky structure; firm, hard; few slickensides; few soft carbonate spots that have hard centers; moderately alkaline; clear, wavy boundary.

B31—30 to 42 inches, dark reddish-brown (5YR 3/4) clay, reddish brown (5YR 5/4) dry; weak, medium, subangular blocky structure; firm, hard; few fine concretions; pockets of silt on peds and in crevices; few small carbonate spots that have hard centers; moderately alkaline; clear, wavy boundary.

B32—42 to 56 inches, dark reddish-brown (2.5YR 3/4) clay, reddish brown (2.5YR 5/4) dry; massive; very firm, very hard; few small carbonate spots and streaks; moderately alkaline; gradual, wavy boundary.

The Ap horizon is dark brown or dark reddish brown. It is slightly acid to mildly alkaline.

The B2 horizon is neutral to moderately alkaline. Grayish mottles are at a depth of less than 30 inches, and slickensides are at a depth of less than 40 inches. The B3 horizon is neutral to moderately alkaline.

Moreland soils have a seasonal high water table between depths of 12 and 24 inches for short duration during wet periods. Moreland soils are associated with Latanier soils. They differ from Latanier soils in lacking a loamy horizon below a depth of 20 to 36 inches.

Moreland clay (Mo).—This nearly level soil is on flood plains. It is subject to occasional flooding of brief duration during wet periods.

Included with this soil in mapping are about 3 percent Mason soils, and 10 percent Latanier soils.

If drained, areas of this soil are suited to such crops as small grain, corn, soybeans, grain sorghum, alfalfa, and tame pasture plants.

Management is needed that maintains or improves soil structure and fertility, provides drainage, and controls flooding. Practices needed are returning residue to the soil, fertilization, and minimum tillage. Rows should be arranged in directions that will provide for surface drainage. Capability unit IIIw-1; Heavy Bottomland range site; pasture and hayland suitability group 1A; tree suitability group 4.

Newtonia Series

The Newtonia series consists of deep, very gently sloping to gently sloping soils on uplands. These soils formed under a cover of native grasses in loamy sediment.

In a representative profile the surface layer is 14 inches of dark-brown silt loam. The upper part of the subsoil, extending to a depth of 22 inches, is dark-brown silt loam. The middle part, to a depth of 34 inches, is dark reddish-brown silty clay loam. The lower part, extending to a depth of 80 inches, is red silty clay loam.

Newtonia soils are well drained and are moderately permeable. Available water capacity is high.

Representative profile of Newtonia silt loam, 3 to 5 percent slopes, 2,880 feet east and 200 feet north of the southwest corner of sec. 20, T. 17 N., R. 16 E.:

A1—0 to 14 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) dry; weak, fine, granular structure; friable, slightly hard; many roots; slightly acid; gradual, smooth boundary.

B1—14 to 22 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; weak, medium, granular structure; firm, hard; slightly acid; gradual, smooth boundary.

B21t—22 to 34 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 5/4) dry; few dark reddish-brown (5YR 3/4) cores in root and worm channels; moderate, medium, subangular blocky structure; very firm, very hard; continuous clay films on ped surfaces; medium acid; gradual, smooth boundary.

B22t—34 to 60 inches, red (2.5YR 4/6) silty clay loam, red (2.5YR 5/6) dry; moderate, medium, subangular blocky structure, clay films on ped surfaces; few patches of reddish-brown (2.5YR 4/4) clean sand; medium acid; gradual, smooth boundary.

B3—60 to 80 inches, red (2.5YR 4/6) silty clay loam, light red (2.5YR 6/6) dry; few light yellowish-brown (10YR 6/4) sand coatings; weak, medium, subangular blocky structure; very firm, very dark concretions; strongly acid.

The A1 horizon is dark brown, very dark brown, or dark reddish brown. It is slightly acid or medium acid.

The B1 horizon is dark-brown, brown, dark reddish-brown, or reddish-brown silt loam or silty clay loam. It is slightly acid to strongly acid.

The B21t and B22t horizons are dark reddish brown, dark red, red, reddish brown, or yellowish red. They are medium acid or strongly acid.

The B3 horizon is dark reddish-brown, dark-red, red, reddish-brown, or yellowish-red silty clay loam, silty clay, or clay. It is strongly acid.

Newtonia soils are associated with Lula and Okay soils. They differ from Lula soils in being more than 60 inches deep to bedrock. Newtonia soils differ from Okay soils by being less than 15 percent material coarser than very fine sand in the upper part of the B horizon.

Newtonia silt loam, 1 to 3 percent slopes (NeB).—This very gently sloping soil is on uplands.

Included with this soil in mapping are about 15 percent Okay soils, 5 percent Bates soils, and 10 percent Dennis soils.

Areas of this soil are used for small grain, grain sorghum, corn, soybeans, alfalfa, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terraces, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 7.

Newtonia silt loam, 3 to 5 percent slopes (NeC).—This gently sloping soil is on uplands. It has the profile described as representative of the series (fig. 10).

Included with this soil in mapping are about 12 percent Dennis soils, 10 percent Bates soils, and 8 percent Okay soils.

Areas of this soil are used for grain sorghum, soybeans, small grain, corn, alfalfa, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and that controls erosion. Practices needed in places are management of crop residue, fertilization, terraces, contour farming, and minimum tillage. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 7.

Newtonia silt loam, 2 to 5 percent slopes, eroded (NeC2).—This moderately eroded, very gently sloping to gently sloping soil is on uplands. It has a profile similar to that described as representative of the series, but part of the original surface layer has been removed by erosion. Rills and gullies that have a depth of 1 to 4 feet are present. The original surface layer and the subsoil have been mixed by cultivation in about 20 percent of the area.

Included with this soil in mapping are about 5 percent Bates soils, 4 percent Linker soils, 4 percent Kamie soils, and 8 percent Okay soils.

Areas of this soil are used for small grain, soybeans, grain sorghum, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Row crops are not generally suited. Practices needed in places are management of crop residue, fertilization, terraces, contour farming, and minimum tillage or no tillage. Capability unit IIIe-1; Loamy Prairie range

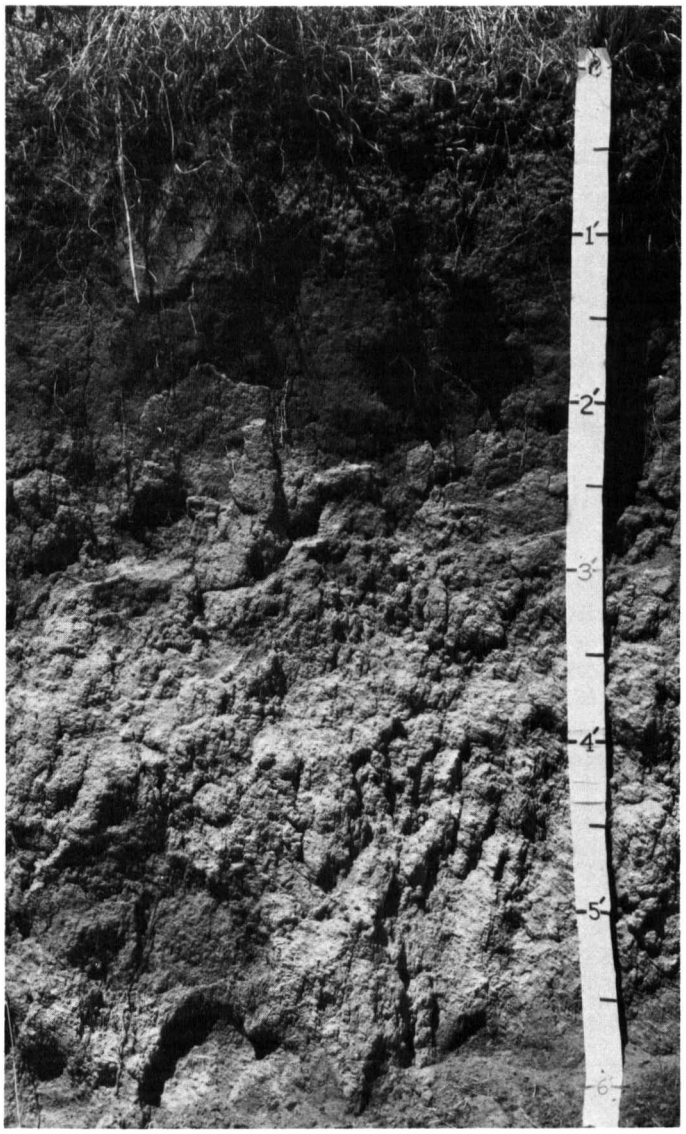

Figure 10.—**Profile of Newtonia silt loam showing the dark surface layer and subangular blocky structure in the subsoil.**

site; pasture and hayland suitability group 8A; tree suitability group 7.

Okay Series

The Okay series consists of deep, very gently sloping or gently sloping soils on uplands. These soils formed under a cover of native grass and scattered oak trees in loamy sediment.

In a representative profile the surface layer is 13 inches of very dark grayish-brown loam. The upper part of the subsoil, extending to a depth of 18 inches, is dark reddish-brown loam. The next part, to a depth of 26 inches, is reddish-brown clay loam. Below this, to a depth of 40 inches, is yellowish-red clay loam. The lower part, extending to a depth of 66 inches, is reddish-brown fine sandy loam.

Okay soils are well drained and are moderately permeable. Available water capacity is high.

Representative profile of Okay loam, 3 to 5 percent slopes, 1,250 feet east and 100 feet north of the southwest corner of sec. 25, T. 16 N., R. 16 E.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak, fine, granular structure; friable, slightly hard; few fine roots; medium acid; abrupt, smooth boundary.

A1—6 to 13 inches, very dark grayish-brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate, medium, granular structure; friable, slightly hard; few fine roots; medium acid; gradual, smooth boundary.

B1—13 to 18 inches, dark reddish-brown (5YR 3/3) loam, reddish brown (5YR 5/3) dry; moderate, fine, subangular blocky structure; friable, hard; few fine roots; thin, patchy clay films on ped surfaces; slightly acid; gradual, smooth boundary.

B21t—18 to 26 inches, reddish-brown (5YR 4/4) clay loam, reddish brown (5YR 5/4) dry; moderate, medium, subangular blocky structure; firm, very hard; thick, patchy clay films on ped surfaces; few fine roots; medium acid; gradual, smooth boundary.

B22t—26 to 40 inches, yellowish-red (5YR 4/6) clay loam, reddish yellow (5YR 6/6) dry; weak, medium, subangular blocky structure; firm, very hard; thick, patchy clay films on ped surfaces; strongly acid; gradual, smooth boundary.

B3—40 to 66 inches, reddish-brown (5YR 5/4) fine sandy loam, light reddish brown (5YR 6/4) dry; weak, medium, subangular blocky structure; friable, hard; strongly acid.

The A1 or Ap horizon is very dark grayish brown, dark brown, very dark brown, or dark reddish brown. It is slightly acid or medium acid.

The B1 horizon is dark reddish-brown, dark reddish-gray, reddish-brown, brown, or dark-brown loam, clay loam, or sandy clay loam. It is medium acid or slightly acid.

The B2t horizon is dark reddish-brown, dark-red, reddish-brown, red, yellowish-red, brown, or dark-brown loam, sandy clay loam, or clay loam. It is slightly acid to strongly acid.

The B3 horizon has the same colors as the B2t horizon. It is fine sandy loam, loam, or sandy clay loam. This horizon is neutral to strongly acid.

Okay soils are associated with Kamie and Newtonia soils. They differ from Kamie soils by having a darker, thicker A horizon and by lacking an A2 horizon. Okay soils differ from Newtonia soils by being more than 15 percent material coarser than very fine sand in the upper part of the B horizon.

Okay loam, 1 to 3 percent slopes (OaB).—This very gently sloping soil is on uplands.

Included with this soil in mapping are about 18 percent Newtonia soils, 12 percent Kamie soils, and 5 percent Choteau soils.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, alfalfa, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terraces, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Okay loam, 3 to 5 percent slopes (OaC).—This gently sloping soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 15 percent of the acreage, is a soil that is similar

to this Okay soil but is less than 18 percent clay in the upper part of the subsoil. Included areas of Newtonia soils make up 15 percent of the acreage; Kamie soils, 7 percent; and Choteau soils, 3 percent.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, alfalfa, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 5.

Okemah Series

The Okemah series consists of deep, nearly level soils on uplands. These soils formed under a cover of native grasses in clayey and loamy sediment.

In a representative profile the surface layer is 16 inches of very dark gray silt loam. The next layer, extending to a depth of 23 inches, is very dark grayish-brown silt loam. The upper part of the subsoil, extending to a depth of 34 inches, is very dark grayish-brown silty clay. The middle part, to a depth of 48 inches, is dark grayish-brown silty clay. The lower part, extending to a depth of 34 inches, is very dark grayish-brown, strong-brown, and very dark grayish-brown silty clay.

Okemah soils are moderately well drained and are slowly permeable. Available water capacity is high.

Okemah soils have a seasonal high water table at a depth of about 2 to 3 feet for short duration during wet periods.

Representative profile of Okemah silt loam, 0 to 1 percent slopes, 660 feet northwest of the southeast corner of NE¼ sec. 11, T. 16 N., R. 18 E.:

A11—0 to 10 inches, very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate, fine, granular structure; friable, hard; many roots; medium acid; clear, smooth boundary.

A12—10 to 16 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate, fine, granular structure; friable, hard; thin gray coatings on ped surfaces; medium acid; clear, smooth boundary.

A3—16 to 23 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish-brown (10YR 5/2) dry; few, fine, distinct, dark yellowish-brown mottles; moderate, medium, granular structure parting to moderate, fine, subangular blocky; very hard; medium acid; clear, wavy boundary.

B21t—23 to 34 inches, very dark grayish-brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; common, fine, faint, dark yellowish-brown mottles; weak, medium, subangular blocky structure; very firm, very hard; clay films on ped surfaces; many dark concretions; mildly alkaline; gradual, smooth boundary.

B22t—34 to 48 inches, dark grayish-brown (2.5YR 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common, medium, faint, yellowish-brown (10YR 5/6) mottles, and common, medium, distinct, dark-brown (7.5YR 4/4) mottles; weak, medium, blocky structure; very firm, very hard; clay films on ped surfaces; many dark concretions; neutral; gradual, smooth boundary.

B3—48 to 66 inches, mottled grayish-brown (10YR 5/2), strong-brown (7.5YR 5/6), and very dark grayish-brown (10YR 3/2) silty clay; weak, coarse, blocky structure; extremely firm; extremely hard; many dark concretions; moderately alkaline.

The A horizon is black, very dark brown, very dark gray, or very dark grayish brown. It is medium acid or slightly acid.

The B2t horizon is very dark gray, very dark grayish-brown, dark-gray, or dark grayish-brown silty clay or clay. It is medium acid to mildly alkaline. This horizon has mottles in shades of gray, brown, or red.

The B3 horizon has mottles in shades of gray, yellow, or brown. It is silty clay or clay. This horizon is neutral to moderately alkaline.

Okemah soils are associated with the Bonn soils, clayey subsoil variant, and with Choteau and Dennis soils. Okemah soils have a thicker, darker A horizon than Bonn soils, clayey subsoil variant. They differ from Choteau and Dennis soils by having distinct mottles in the lower part of the A horizon and by matrix colors in the B2t horizon that have a chroma of 1 or 2. In addition, Okemah soils lack the A2 horizon of Choteau soils.

Okemah silt loam, 0 to 1 percent slopes (OkA).—This nearly level soil is on uplands.

Included with this soil in mapping, and making up about 5 percent of the acreage, is a soil that is similar to this Okemah soil but is less than 60 inches deep to shale or limestone. Included areas of Dennis soils make up 10 percent of the acreage, and Summit soils, 5 percent.

Areas of this soil are used for small grain, soybeans, grain sorghum, corn, alfalfa, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, minimum tillage or no tillage, and arrangement of rows for drainage. Capability unit I-2; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Osage Series

The Osage series consists of deep, nearly level soils on flood plains. These soils formed in clayey alluvium under a cover of hardwood forest and an understory of native grasses.

In a representative profile the surface layer is 18 inches of very dark gray clay. The upper part of the subsoil, extending to a depth of 50 inches, is very dark gray clay. The lower part, to a depth of 66 inches, is dark-gray clay.

Osage soils are poorly drained and are very slowly permeable. Available water capacity is high.

The Osage soils have a seasonal high water table at a depth of 1 to 2 feet for a short duration during wet periods. They are subject to occasional flooding of brief duration during wet periods.

Representative profile of Osage clay, 800 feet east and 300 feet south of the center of sec. 18, T. 17 N., R. 17 E.:

A11—0 to 12 inches, very dark gray (10YR 3/1) clay; strong, medium, granular structure; very firm, very hard; pressure faces on peds; slightly acid; gradual, smooth boundary.

A12—12 to 18 inches, very dark gray (10YR 3/1) clay; weak, medium, angular blocky structure; extremely firm, extremely hard; pressure faces on peds; strongly acid; gradual, smooth boundary.

B21g—18 to 36 inches, very dark gray (10YR 3/1) clay; common, fine, faint, brown mottles; weak, fine and medium, angular blocky structure; extremely firm, extremely hard; pressure faces on peds; slightly acid; diffuse, smooth boundary.

B22g—36 to 50 inches, very dark gray (5Y 3/1) clay; common, fine, distinct, reddish-brown mottles; moderate, fine, angular blocky structure; extremely firm, extremely hard; pressure faces on peds; few slickensides; neutral; gradual, smooth boundary.

B3g—50 to 66 inches, dark-gray (N 4/0) clay; few, fine, distinct, dark-brown mottles; weak, medium, angular blocky structure; extremely firm, extremely hard; few dark concretions; pressure faces on peds; few slickensides; neutral.

This soil is strongly acid to mildly alkaline throughout.

The A horizon is very dark gray, very dark grayish-brown, black, or very dark brown clay or silty clay loam. It has few, fine, faint, or common, fine, distinct, reddish-brown mottles in the lower part in places.

The B2g and B3 horizons are clay or silty clay. The B3 horizon contains gypsum crystals in places.

Osage soils are associated with and are similar to Moreland soils. They are more clayey throughout than Radley soils. They are more acid than Moreland soils.

Osage silty clay loam (Os).—This nearly level soil is on flood plains. It has a profile similar to that described as representative of the series, except the texture of the surface layer is silty clay loam. This soil is subject to occasional flooding of brief duration during wet periods.

Included with this soil in mapping, and making up 5 percent of the acreage, is a soil that is similar to this Osage soil but lacks a subsoil and is less clayey below the surface layer. Included areas of Osage clay make up about 15 percent of the acreage and included areas of Radley soils, about 10 percent.

Areas of this soil are used for small grain, corn, grain sorghum, soybeans, alfalfa, tame pasture, pecans, and hardwoods.

Management is needed that maintains or improves soil structure and fertility and that controls erosion. Practices needed in places are management of crop residue, fertilization, drainage, and minimum tillage or no tillage. Rows need to be arranged in directions that will provide for surface drainage in some areas. Flood-control measures are needed. Capability unit IIw-2; Heavy Bottomland range site; pasture and hayland suitability group 2B; tree suitability group 4.

Osage clay (Oy).—This nearly level soil is on flood plains (fig. 11). It has the profile described as representative of the series. This soil is subject to occasional flooding of brief duration during wet periods.

Figure 11.—**Landscape of Osage clay showing cracks in the unplowed area and the rough, cloddy condition of the plowed field.**

Included with this soil in mapping, and making up about 15 percent of the acreage, is a soil that is less clayey in the upper part of the subsoil than this Osage soil. Included areas of Radley soils make up 4 percent of the acreage.

If drained, areas of this soil are used for such crops as grain sorghum, small grain, soybeans, corn, alfalfa, tame pasture plants, pecans, and hardwoods.

Management is needed that maintains or improves soil structure and fertility and surface drainage. Practices needed include returning residue to the soil, fertilization, and minimum tillage. A complete drainage system is needed along with an arrangement of rows in directions that will provide for additional surface drainage. Flood-control measures are needed. Capability unit IIIw-1; Heavy Bottomland range site; pasture and hayland suitability group 1B; tree suitability group 4.

Parsons Series

The Parsons series consists of deep, nearly level soils on uplands. These soils formed under a cover of native grass in loamy or clayey sediment.

In a representative profile the surface layer is 9 inches of very dark grayish-brown silt loam. The subsurface layer, extending to a depth of 12 inches, is grayish-brown silt loam. The upper part of the subsoil, extending to a depth of 22 inches, is very dark grayish-brown clay. The middle part, to a depth of 36 inches, is grayish-brown clay. The lower part, extending to a depth of 58 inches, is coarsely mottled, gray, yellowish-brown, and yellowish-red clay. The underlying material, to a depth of 80 inches, is coarsely mottled, gray, yellowish-brown, and very dark gray clay.

Parsons soils are somewhat poorly drained and are very slowly permeable. Available water capacity is high.

These soils have a seasonal high water table at a depth of 0 to 12 inches for a short duration during wet periods.

Representative profile of Parsons silt loam, 0 to 1 percent slopes, 1,000 feet south and 175 feet east of the northwest corner of sec. 34, T. 18 N., R. 18 E.:

A1—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; friable, slightly hard; few, fine, dark concretions; strongly acid; gradual, smooth boundary.

A2—9 to 12 inches, grayish-brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; many, medium, faint, dark-brown (10YR 4/3) mottles; weak, medium, granular structure; friable; slightly hard; many roots; many, small, dark concretions; strongly acid; abrupt, smooth boundary.

B21tg—12 to 22 inches, very dark grayish-brown (10YR 3/2) clay, grayish brown (10YR 5/2) dry; common, medium, distinct, strong-brown (7.5YR 5/6) and reddish-brown (5YR 4/4) mottles; weak, coarse, blocky structure; very firm, extremely hard; many roots; thin clay films on ped surfaces; thin, light-gray (10YR 6/1) coatings on sides of peds; strongly acid; gradual, smooth boundary.

B22tg—22 to 36 inches, grayish-brown (10YR 5/2) clay, light brownish gray (10YR 6/2) dry; many, coarse, distinct, reddish-brown (5YR 4/4) and strong-brown (7.5YR 5/6) mottles; weak, coarse, blocky structure; very firm, extremely hard; thin clay films on ped surfaces; few, fine, dark concretions; medium acid; gradual, smooth boundary.

B23t—36 to 45 inches, coarsely mottled, gray (10YR 5/1), yellowish-brown (10YR 5/6), and yellowish-red (5YR 4/6) clay; weak, coarse, blocky structure; very firm, very hard; patchy clay films on peds; medium acid; gradual, smooth boundary.

B3—45 to 58 inches, coarsely mottled, gray (10YR 5/1), yellowish-brown (10YR 5/6), and yellowish-red (5YR 4/6) clay; weak, coarse, blocky structure; very firm, very hard; common gypsum crystals; few fragments of siltstone; few dark concretions; neutral; gradual, smooth boundary.

C—58 to 80 inches, coarsely mottled, gray (10YR 5/1), yellowish-brown (10YR 5/6), and very dark gray (10YR 3/1) clay; massive; very firm, very hard; rounded fragments of siltstone; many dark concretions; neutral.

The A1 or Ap horizon is very dark grayish brown or dark grayish brown. It is slightly acid to strongly acid.

The A2 horizon is dark grayish brown, grayish brown, dark gray, or gray. It is medium acid or strongly acid.

The B2t horizon is very dark grayish-brown, gray, dark-gray, very dark gray, grayish-brown, or dark grayish-brown clay, silty clay, or silty clay loam. It is medium acid or strongly acid. This horizon has mottles in shades of gray, brown, or red.

The B3 and C horizons have the same color and texture range as the B22tg horizon. They are strongly acid to mildly alkaline. These horizons have mottles in shades of gray, brown, or red.

Parsons soils are associated with Bonn, clayey subsoil variant, and Taloka soils. They lack the interfingering of the A2 material into the B horizon of Bonn, clayey subsoil variant. Parsons soils differ from Taloka soils by having an A horizon less than 16 inches thick.

Parsons silt loam, 0 to 1 percent slopes (PaA).—This nearly level soil is on uplands.

Included with this soil in mapping, and making up about 12 percent of the acreage, is a soil that is similar to this Parsons soil but has a dark yellowish-brown surface layer. Included areas of Okemah soils make up 16 percent of the acreage; Taloka soils, 4 percent; Dennis soils, 5 percent; and Bonn soils, clayey subsoil variant, 3 percent.

Areas of this soil are used for small grain, grain sorghum, soybeans, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, minimum tillage or no tillage, and arrangement of rows in directions that will provide for drainage. Capability unit IIs-1; Claypan Prairie range site; pasture and hayland suitability group 8C; tree suitability group 8.

Radley Series

The Radley series consists of deep, nearly level to gently sloping soils on flood plains. These soils formed under a cover of hardwood forest and an understory of native grasses in loamy sediment.

In a representative profile the surface layer is 14 inches of very dark grayish-brown silt loam. The upper part of the underlying material, extending to a depth of 40 inches, is dark-brown silty clay loam. The lower part, to a depth of 66 inches, is brown silt loam.

Radley soils are moderately well drained and are moderately permeable. Available water capacity is high.

Representative profile of Radley silt loam, 1,700 feet south and 300 feet east of the northwest corner of sec. 15, T. 19 N., R. 16 E.:

A1—0 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate, fine, granular structure; friable, slightly hard; few fine roots; slightly acid; gradual, smooth boundary.

C1—14 to 26 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate, medium, granular structure; friable, hard; few fine roots; slightly acid; gradual, smooth boundary.

C2—26 to 40 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few, fine, faint, yellowish-brown and gray mottles; weak, medium, granular structure; firm, hard; strata of sandier material; neutral; gradual, smooth boundary.

C3—40 to 66 inches, brown (10YR 4/3) silt loam, pale brown (10YR 5/3) dry; common, medium, distinct, gray (10YR 5/1), yellowish-brown (10YR 5/6), and red (2.5YR 4/6) mottles; weak, fine, granular structure; firm, hard; strata of sandier material; slightly acid.

Texture of these soils is silt loam or silty clay loam to a depth of 66 inches or more.

The A horizon is very dark brown, dark brown, very dark grayish brown, or black. It is neutral to medium acid.

The C1 and C2 horizons are dark brown, brown, grayish brown, or dark grayish brown. They are neutral to medium acid. In places these horizons have mottles below a depth of 20 inches that have chromas of more than 2.

The C3 horizon is dark brown, brown, grayish brown, dark grayish brown, very dark grayish brown, very dark brown, very dark gray, dark gray, gray, or black. It is neutral to medium acid.

Radley soils are associated with Choska, Mason, and Osage soils. They are finer textured between depths of 10 and 40 inches than Choska soils. They differ from Mason soils by lacking a B horizon. Radley soils differ from Osage soils by lacking a B horizon and by having less clay between depths of 10 and 40 inches.

Radley silt loam (Ra).—This nearly level soil is on flood plains. It has the profile described as representative of the series. This soil is subject to occasional flooding of brief duration during wet periods.

Included with this soil in mapping, and making up about 12 percent of the acreage, is a soil that is similar to this Radley soil but has a thicker surface layer. Included areas of a soil that is similar to this Radley soil but has mottles with chromas of 2 at a depth of 16 to 20 inches make up 8 percent of the acreage, and included areas of Osage soils, 8 percent.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, alfalfa, tame pasture plants, pecans, and hardwoods (fig. 12).

Figure 12.—**First cutting of alfalfa ready for harvest on Radley silt loam.**

Management is needed that maintains or improves soil structure and fertility and prevents flooding. Practices needed include returning residue to the soil, fertilization, and minimum tillage. Arrangement of rows in directions that will provide for surface drainage is needed. Flood prevention measures are needed in most areas. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 1.

Radley soils, channeled (Rc).—This nearly level or gently sloping soil is on flood plains. Slopes are 0 to 5 percent. This soil has a profile similar to that described as representative of the series, except the surface layer ranges from silt loam to silty clay loam. It is subject to frequent flooding of brief duration during wet periods.

Included with this soil in mapping, and making up 18 percent of the acreage, is a soil that is similar to this Radley soil but has a surface layer more than 20 inches thick. Included areas of Choska soils make up about 15 percent of the acreage and included areas of Rock outcrop, 3 percent.

Areas of this soil are used mainly for tame pasture plants or for trees because of frequent flooding. The quality of the tame pasture can be maintained or improved by controlling brush, by using lime and fertilizer, by using suitable grazing practices, and by surface drainage. The woodland can be maintained or improved by protecting from fire, removing or controlling interior species, planting suitable species where absent, and selectively harvesting trees on a planned schedule. Capability unit Vw-1; Loamy Bottomland range site; pasture and hayland suitability group 2A; tree suitability group 1.

Rock Outcrop

In this county Rock outcrop is mapped only as part of Catoosa-Rock outcrop complex, 1 to 8 percent slopes (CcD).The Rock outcrop occurs in such an intricate pattern that it is impractical to map it separately. This land type consists of limestone rock that is exposed at the surface and that includes thinly mantled bedrock covered with less than 3 inches of soil material.

Summit Series

The Summit series consists of deep, very gently sloping or gently sloping soils on uplands. These soils formed under a cover of native grasses in material weathered from limestone or calcareous shale.

In a representative profile the surface layer is 12 inches of black silty clay loam. The upper part of the subsoil, extending to a depth of 16 inches, is black silty clay loam. The middle part, to a depth of 28 inches, is very dark brown clay. The lower part, extending to a depth of 40 inches, is dark grayish-brown clay. The underlying material, to a depth of 60 inches, is olive-brown clay.

Summit soils are moderately well drained and are slowly permeable. Available water capacity is high. These soils have a seasonal high water table at a depth of 24 to 36 inches for a short duration during wet periods.

Representative profile of Summit silty clay loam, 3 to 5 percent slopes, 1,000 feet north and 100 feet east of the southwest corner of sec. 6, T. 18 N., R. 15 E.:

A1—0 to 12 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; strong, medium, granular structure; friable, hard; many roots; slightly acid; gradual, smooth boundary.

B1—12 to 16 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; strong, medium, granular structure; firm, very hard; many roots; slightly acid; gradual, smooth boundary.

B21t—16 to 28 inches, very dark brown (10YR 2/2) clay, dark grayish brown (10YR 4/2) dry; few, fine, faint, gray mottles; moderate, medium, blocky structure; very firm, extremely hard; clay films on ped surfaces; shiny ped faces; neutral; gradual, smooth boundary.

B22t—28 to 40 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; common, medium, distinct, yellowish-brown (10YR 5/6) mottles and common, medium, faint, olive-brown (2.5Y 4/4) mottles; moderate, medium, blocky structure; very firm, extremely hard; clay films on ped surfaces; shiny ped faces; few calcium carbonate and iron-manganese concretions; neutral; diffuse, smooth boundary.

C—40 to 60 inches, olive-brown (2.5Y 4/4) clay, light yellowish brown (2.5Y 6/4) dry; many, medium, faint, dark grayish-brown (2.5YR 4/2), yellowish-brown (10YR 5/8), and gray (10YR 6/1) mottles; massive; very firm, extremely hard; few calcium carbonate and iron-manganese concretions; moderately alkaline.

Thickness of the solum is 30 to 50 inches, and depth to bedrock is more than 40 inches.

The A1 horizon is black, very dark brown, very dark gray, or very dark grayish brown. It is slightly acid or medium acid. This horizon has cracks ½ inch or more in width and 12 inches or more in length during some seasons of most years.

The B1 horizon is similar in color and reaction to the A horizon. It is silty clay loam, clay, or silty clay. This horizon has cracks ½ inch or more in width and 12 inches or more in length during some seasons of most years.

The B21t horizon is dark grayish-brown, brown, olive-brown, very dark brown, very dark gray, very dark grayish-brown, dark grayish-brown, dark-brown, or dark yellowish-brown clay or silty clay. It is slightly acid or neutral. This horizon has mottles in shades of gray and brown. In places it has iron-manganese concretions or limestone fragments.

The B22t horizon is dark-brown, brown, very dark grayish-brown, dark yellowish-brown, dark grayish-brown, very dark brown, or olive-brown clay or silty clay. It is slightly acid to moderately alkaline.

The C horizon has mottles in shades of brown and gray.

Summit soils are associated with Catoosa and Lula soils. They differ from Catoosa soils in that they are more than 40 inches deep to bedrock and are more than 35 percent clay in the upper part of the B horizon. The surface of Summit soils, unlike that of Lula soils, cracks during dry years. Summit soils also differ from Lula soils in that they are more than 35 percent clay in the upper part of the B horizon.

Summit silty clay loam, 1 to 3 percent slopes (SuB).—This very gently sloping soil is on uplands.

Included with this soil in mapping, and making up about 2 percent of the acreage, is a soil that is similar to this Summit soil but has bedrock at a depth of less than 30 inches. Included areas of Dennis soils make up 5 percent of the acreage; Okemah soils and Lula soils, each 3 percent; and Catoosa soils, 2 percent. Rock outcrop is present in a few places.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, alfalfa, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Summit silty clay loam, 3 to 5 percent slopes (SuC).—This gently sloping soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 15 percent of the acreage, is a soil that is similar to this Summit soil but has limestone or shale at a depth of less than 30 inches. Included areas of Lula soils and Dennis soils each make up 3 percent of the acreage. Rock outcrop is present in a few places.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, alfalfa, tame-pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Row crops are not generally suited to this soil. Practices needed in places are management of crop residue, fertilization, terracing, contour farming, and minimum tillage or no tillage. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland suitability group 8A; tree suitability group 8.

Taloka Series

The Taloka series consists of deep, nearly level or very gently sloping soils on uplands. These soils formed under a cover of native grasses in loamy old alluvium.

In a representative profile the surface layer is 8 inches of very dark grayish-brown silt loam. The upper part of the subsurface layer, extending to a depth of 20 inches, is dark grayish-brown silt loam. The lower part, to a depth of 28 inches, is grayish-brown silt loam. The upper part of the subsoil, extending to a depth of 34 inches, is dark grayish-brown silty clay. The middle part, to a depth of 60 inches, is brown silty clay loam. The lower part, extending to a depth of 78 inches, is coarsely mottled silty clay loam.

Taloka soils are somewhat poorly drained and are very slowly permeable. Available water capacity is high. These soils have a seasonal high water table at a depth of 0 to 12 inches for a short duration during wet periods.

Representative profile of Taloka silt loam, 1 to 3 percent slopes, 275 feet southeast of Oklahoma Highway 2, where it crosses the north section line in sec. 2, T. 16 N., R. 18 E.:

A1—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak, medium, granular structure; slightly hard, friable; medium acid; gradual, smooth boundary.

A21—8 to 20 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few, fine, faint, yellowish-brown mottles; weak, fine, granular structure; slightly hard, friable; strongly acid; gradual, smooth boundary.

A22—20 to 28 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few, fine, faint and distinct, yellowish-brown mottles; weak, fine, granular structure; slightly hard, friable; many, fine, black concretions; common medium bodies of dark yellowish-brown (10YR 4/4) clay in lowest 1 inch; strongly acid; abrupt, smooth boundary.

B21t—28 to 34 inches, dark grayish-brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; many, medium, faint, yellowish-brown (10YR 5/6) mottles and common, fine and medium, prominent, red (2.5YR 4/6) mottles; weak, coarse, prismatic structure parting to moderate, medium, blocky; very hard, very firm; thin, nearly continuous clay films on ped surfaces; medium acid; gradual, smooth boundary.

B22t—34 to 44 inches, brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common, medium, faint, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 4/6) mottles and few, fine, prominent, red mottles; moderate, medium, blocky structure; very hard, very firm; dark grayish-brown (10YR 4/2) clay films on ped surfaces; shiny clay films on tops and bottoms of peds; many, fine, black concretions; neutral; gradual, smooth boundary.

B23t—44 to 60 inches, brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few, medium, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; weak, medium, blocky structure; very hard, firm; dark grayish-brown (10YR 4/2) clay films on ped surfaces; shiny clay films on tops and bottoms of peds; few, fine, black concretions; few gypsum crystals; neutral; gradual, smooth boundary.

B3—60 to 78 inches, coarsely mottled, light-gray (10YR 7/1), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/6) silty clay loam; weak, medium, blocky structure; very hard, firm; few, fine, black concretions; many gypsum crystals; neutral.

The A1 or Ap horizon is very dark gray or very dark grayish brown. It is medium acid or strongly acid.

The A2 horizon is dark grayish brown or grayish brown. It has many dark concretions and includes mottles of higher chroma in the lower part.

The B2t horizon is dark-gray, dark grayish-brown, dark-brown, or brown silty clay loam, clay loam, silty clay, or clay. It has mottles in shades of brown, red, or gray. This horizon is neutral to strongly acid.

The B3 horizon is similar in color and texture to the B2t horizon but has coarse mottles in shades of gray or brown. It is slightly acid to moderately alkaline.

Taloka soils are associated with Choteau and Parsons soils. They differ from the Choteau soils by having a 20-percent increase in clay content between the lower boundary of A2 horizon and the upper boundary of the B2t horizon. They differ from Parsons soils by having an A horizon more than 16 inches thick.

Taloka silt loam, 0 to 1 percent slopes (TaA).—This nearly level soil is on uplands.

Included with this soil in mapping, and making up about 16 percent of the acreage, is a soil that is similar to this Taloka soil but has a dark grayish-brown surface layer. Included areas of Choteau soils make up 12 percent of the acreage.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, tame pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and that controls erosion. Practices needed in places are management of crop residue, fertilization, minimum tillage or no tillage, and arrangement of rows in directions that will provide for drainage. Capability unit IIs-1; Loamy Prairie range site; pasture and hayland suitability group 8C; tree suitability group 8.

Taloka silt loam, 1 to 3 percent slopes (TaB).—This very gently sloping soil is on uplands. It has the profile described as representative of the series.

Included with this soil in mapping, and making up about 4 percent of the acreage, is a soil that is similar to this Taloka soil but has a dark grayish-brown surface layer. Included areas of Choteau soils make up 12 percent of the acreage and included areas of Dennis soils, 6 percent.

Areas of this soil are used for small grain, corn, soybeans, grain sorghum, tame-pasture plants, and native range.

Management is needed that maintains or improves soil structure and fertility and controls erosion. Practices needed in places are management of crop residue, fertilization, terraces, contour farming, and minimum tillage or no tillage. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland suitability group 8C; tree suitability group 8.

Tullahassee Series

The Tullahassee series consists of deep, nearly level soils on flood plains. These soils formed under a cover of hardwood forest in loamy alluvium.

In a representative profile the surface layer is 16 inches of dark-brown fine sandy loam. The upper part of the underlying material, extending to a depth of 30 inches, is dark-brown fine sandy loam. The middle part, to a depth of 56 inches, is pale-brown fine sandy loam. The lower part, to a depth of 64 inches or more, is dark grayish-brown stratified fine sandy loam and loam.

Tullahassee soils are somewhat poorly drained and are moderately rapidly permeable. Available water capacity is moderate. These soils have a seasonal high water table at a depth of 0 to 18 inches for a short duration during wet periods. They are subject to frequent flooding of brief duration during wet periods.

Representative profile of Tullahassee fine sandy loam, 2,640 feet west and 100 feet north of the southeast corner of sec. 20, T. 17 N., R. 15 E.:

A1—0 to 16 inches, dark-brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak, fine, granular structure; very friable, soft; many fine roots; bedding planes in lower part; slightly acid; gradual, smooth boundary.

C1—16 to 30 inches, dark-brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; common, medium, distinct, light-gray (10YR 7/2) and yellowish-brown (10YR 5/6) mottles; massive with bedding planes; friable, soft; slightly acid; gradual, smooth boundary.

C2—30 to 56 inches, pale-brown (10YR 6/3) fine sandy loam, very pale brown (10YR 7/3) dry; common, medium, faint, light brownish-gray (10YR 6/2) mottles and few, fine, distinct, reddish-brown mottles; massive with bedding planes; friable, slightly hard; slightly acid; gradual, smooth boundary.

C3—56 to 64 inches, dark grayish-brown (10YR 4/2) stratified fine sandy loam and loam, grayish brown (10YR 5/2) dry; few, fine, faint, dark-brown mottles; massive; firm, hard; slightly acid.

The A1 horizon is dark grayish brown, grayish brown, dark brown, or brown. It is slightly acid or medium acid. In some areas this horizon has brown or gray mottles.

The C1 horizon is dark-brown, brown, dark grayish-brown, grayish-brown, yellowish-brown, or dark yellowish-brown loam or fine sandy loam. In places it has strata of coarse or fine material. This horizon is slightly acid or medium acid. It has mottles in shades of brown, gray, red, or yellow.

The C2 or C3 horizons are dark-brown, grayish-brown, brown, dark grayish-brown, light brownish-gray, or pale-brown loam or fine sandy loam. The fine sandy loam is stratified with finer or coarser material. These horizons are slightly acid or medium acid. These horizons have mottles in shades of brown, gray, yellow, or red.

Tullahassee soils are associated with Choska and Kiomatia soils. They differ from Choska soils by having higher color values in the A horizon and by being less than 15 percent material coarser than very fine sand between depths of 10 and 40 inches. Tullahassee soils differ from Kiomatia soils by having gray mottles at a depth of less than 20 inches and by having dominant textures finer than fine sand between depths of 10 and 40 inches.

Tullahassee fine sandy loam (Tu).—This nearly level soil is on flood plains.

Included with this soil in mapping, and making up about 28 percent of the acreage, is a soil that is similar to this Tullahassee soil but is more than 18 percent clay between depths of 10 and 40 inches. Included areas of a soil that is similar to this Tullahassee soil but is sandy throughout make up 12 percent of the acreage.

Areas of this soil are used mainly for tame pasture plants (fig. 13). Bermudagrass is used extensively. Capability unit Vw-2; Loamy Bottomland range site; pasture and hayland suitability group 2B; tree suitability group 2.

Use and Management of the Soils

In this section the system of capability classification used by the Soil Conservation Service is explained, and estimated yields of the principal crops grown in the county are given. The capability classification of each soil mapped in the county can be found by referring to the "Guide to Mapping Units." Information about management needs of a particular soil is given in the section "Descriptions of the Soils."

This section also contains information about management of the soils for cultivated crops and tame pasture, and about the use of the soils for range, trees, wildlife habitat, recreational development, and engineering.

General Management of the Soils for Cultivated Crops [2]

Cultivated soils in this county need management that will conserve moisture, control erosion, maintain fertility, supply organic matter, and preserve good tilth. Some of the management practices commonly required in the county are discussed below. For suggested combinations of practices for specific soils, see "Descriptions of the Soils."

The information in this section can be used with that in the descriptions of the mapping units to help the farmer and rancher select appropriate practices for specific soils. Most good management practices accomplish more than one purpose and can be used on nearly all the cropland in the county.

Minimum tillage.—Where soils are to be cropped, they must be worked to prepare a seedbed, to control

[2] By ERNEST O. HILL, agronomist, Soil Conservation Service.

Figure 13.—Bermudagrass pasture in an area of Tullahassee fine sandy loam.

weeds, and to provide a variable place for the growth of plant roots. Excessive tillage breaks down the soil structure and speeds up the decomposition of organic matter. The soils then tend to puddle and crust at the surface, take in less water and air, and store less moisture for plant growth.

Minimum tillage is accomplished by using a long-term cropping system with perennial grasses or deep-rooted legumes, using herbicides instead of cultivation for weed control, and reducing the number of operations in preparing the seedbed, planting, and cultivating.

Crop residue management.—Leaving crop residue on the surface in winter and spring, or working it partly into the surface, is needed to protect soils from erosion. Organic matter, or humus, supplied in crop residue improves the tilth of the surface layer. The improved tilth then increases infiltration and storage of water, reduces the hazard of erosion, and helps to prevent crusting.

Soil-improving crops.—The main objectives in using soil-improving crops are to maintain or improve the physical condition and the productivity of the soil and to control erosion, weeds, insects, and plant diseases. A cropping system that improves the soil includes crops that produce large amounts of residue.

Crop residue and weeds are the largest source of organic material for maintenance of soil fertility and soil structure. This residue needs the addition of nitrogen fertilizer to prevent a shortage of this nutrient for the succeeding crop.

Soil-depleting crops.—Crops that do not help to control erosion, improve soil structure, or build up the organic-matter content are soil-depleting crops. Minimum use of these crops is made in a good cropping system. Clean-tilled crops, if the forage is removed for silage or cut low for bundle feed or hay, and soybeans cut for hay are soil depleting if most of the top growth is removed each year.

Cover crops.—Cover crops generally consist of small grain with vetch or annual lespedeza grown to improve the soil and protect it from erosion. Small grain, overseeded with annual lespedeza, is an example of a warm-season cover crop. Small grain and vetch are suitable cool-season cover crops.

Grassed waterways.—Grassed waterways consist mainly of broad, flat-bottomed channels seeded or sodded with perennial plants. Bermudagrass or native grasses are commonly used. Grassed waterways are

needed for terrace outlets to provide safe disposal of excess water. They are also used with diversion terraces and in natural drains.

Capability grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on permanent limitations of soils when used for field crops, the risk of damage when they are farmed, and the way the soils respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range, for trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. The subclass indicates major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclasses are indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* used only in some parts of the United States and not in Wagoner County, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, or wildlife.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, require about the same management, and have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally, for example, IIe-1 or IIIs-1.

The eight classes in the capability system and the subclasses and units in Wagoner County are described in the list that follows. The capability unit of each soil is given in the "Guide to Mapping Units."

Class I. Soils that have few limitations that restrict their use.
- (No subclass)
  - Unit I-1. Deep, nearly level, well-drained, loamy soils having a loamy subsoil or sandy and loamy underlying materials; on low terraces.
  - Unit I-2. Deep, nearly level, moderately well drained, loamy soils having a clayey subsoil; on uplands.

Class II. Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion unless protected.
  - Unit IIe-1. Deep and moderately deep, very gently sloping, somewhat poorly drained, moderately well drained, or well drained, loamy soils having a loamy or clayey subsoil; on uplands.
  - Unit IIe-2. Moderately deep, very gently sloping, well-drained soils that are loamy throughout; on uplands.
- Subclass IIw. Soils moderately limited because of excess water.
  - Unit IIw-1. Deep, nearly level, moderately well drained soils that are loamy throughout; on flood plains.
  - Unit IIw-2. Deep, nearly level, poorly drained, loamy soils having a clayey subsoil; on flood plains.
- Subclass IIs. Soils moderately limited because of very slow permeability or droughty conditions.
  - Unit IIs-1. Deep, nearly level, somewhat poorly drained, loamy soils having a loamy or clayey subsoil; on uplands.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe-1. Deep or moderately deep, very gently sloping to gently sloping, well-drained, loamy soils having a loamy or clayey subsoil; on uplands.
  - Unit IIIe-2. Deep, gently sloping, moderately well drained, loamy soils having a loamy and clayey subsoil; on uplands.
  - Unit IIIe-3. Deep or moderately deep, very gently sloping or gently sloping, moderately well drained or well drained, loamy soils having a loamy or clayey subsoil; on uplands.
- Subclass IIIw. Soils severely limited for cultiva-

tion because of excess water or seasonal overflow.
Unit IIIw-1. Deep, nearly level, somewhat poorly drained or poorly drained soils that are clayey throughout; on flood plains.
Unit IIIw-2. Deep, nearly level, somewhat poorly drained, clayey soils having a clayey subsoil that is underlain by loamy sediment; on flood plains.
Subclass IIIs. Soils severely limited for cultivation because of rapid permeability.
Unit IIIs-1. Deep, nearly level, well-drained, loamy soils that are underlain by sandy material; on flood plains.

Class IV. Soils that have very severe limitations that reduce the choice of plants, require very careful management, or both.
Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
Unit IVe-1. Shallow to moderately deep, very gently sloping to gently sloping, well-drained soils that are loamy throughout; on uplands.
Subclass IVs. Soils very severely limited because of high sodium content, low available water capacity, or other soil features.
Unit IVs-1. Deep, nearly level, poorly drained, loamy soils having a clayey subsoil; on uplands.

Class V. Soils that are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.
Subclass Vw. Soils subject to flooding.
Unit Vw-1. Deep, nearly level to very gently sloping, moderately well drained soils that are loamy throughout; on flood plains.
Unit Vw-2. Deep, nearly level, somewhat poorly drained soils that are loamy throughout; on flood plains.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivated crops and restrict their use largely to pasture or range, trees, or wildlife habitat.
Subclass VIe. Soils severely limited chiefly by risk of erosion unless protective cover is maintained.
Unit VIe-1. Deep, nearly level to moderately steep, moderately well drained, loamy soils having a loamy and clayey subsoil or loamy underlying material; on uplands and flood plains.
Unit VIe-2. Deep, sloping to moderately steep, well-drained, sandy soils having a loamy subsoil; on uplands.
Unit VIe-3. Deep, gently sloping to sloping, well-drained, loamy or sandy soils having a loamy subsoil; severely eroded; on uplands.
Unit VIe-4. Shallow and moderately deep, very gently sloping to gently sloping, well drained or somewhat excessively drained soils that are loamy throughout; on uplands.

Class VII. Soils that have very severe limitations that make them unsuited to cultivated crops and restrict their use largely to range, trees, or wildlife food and cover.
Subclass VIIe. Soils very severely limited, chiefly by risk of erosion, unless protective cover is maintained.
Unit VIIe-1. Deep, nearly level to steep, well-drained soils that are loamy throughout; on uplands.
Subclass VIIs. Soils very severely limited by available water capacity, shallowness, stoniness, or other soil characteristics.
Unit VIIs-1. Shallow to moderately deep, very gently sloping to steep, well drained or somewhat excessively drained soils that are loamy throughout; on uplands.
Unit VIIs-2. Deep and shallow, sloping to very steep, well-drained, loamy soils having a loamy or clayey subsoil; on uplands.
Unit VIIs-3. Deep, gently sloping to very steep, well-drained soils that are loamy and shaly throughout; on uplands.

Class VIII. Soils and land types that have limitations that preclude their use for recreation, wildlife habitat, water supply, or esthetic purposes. (None in Wagoner County.)

Predicted yields

Table 2 lists predicted yields of the principal crops grown in the county. The predictions are based on estimates made by farmers, soil scientists, and others who have knowledge of yields in the county and on information taken from research data. The predicted yields are average yields per acre that can be expected by good commercial farmers at the level of management that tends to produce the highest economic returns. The yields are for dryland soils.

Crops other than those shown in table 2 are grown in the county, but their predicted yields are not included because their acreage is small or reliable data on yields are not available. Absence of a yield indicates the crop is not suited to or is not commonly grown on the soil.

The predicted yields given in table 2 can be expected if—

1. Rainfall is effectively used and conserved.
2. Surface or subsurface drainage systems, or both, are installed.
3. Crop residue is managed to maintain soil tilth.
4. Minimum but timely tillage is used.
5. Insect, plant-disease, and weed-control measures are consistently used.
6. Fertilizer is applied according to soil test and crop needs.
7. Suited crop varieties are used at recommended seeding rates.

Use of the Soils for Pasture and Hay [3]

General guidelines for managing soils for pasture and hay are described in this subsection. Following

[3] By ERNEST O. HILL, agronomist, Soil Conservation Service.

TABLE 2.—*Predicted acre yields of crops and pasture plants*

[All yields are those to be expected under a high level of management. Absence of a yield figure indicates that the crop is seldom grown or is not suited]

Soil series and map symbols	Wheat	Corn	Soybeans	Grain sorghum	Alfalfa	Improved bermuda-grass	Tall fescue
	Bu	*Bu*	*Bu*	*Bu*	*Tons*	*AUM*[1]	*AUM*[1]
Barge: BaF						5.5	6.0
Bates:							
BbB	30	50	25	50	3.5	6.5	5.5
BbC	25	45	20	45		6.5	5.0
BbC2	35		20	35		5.5	4.0
Bonn, clayey subsoil variant: Bv						3.0	
Catoosa: CcD							
Choska: Cd	40	65	35	75	6.0	8.5	7.0
Choteau: ChB	35	50	30	65	4.0	7.0	5.5
Coweta:							
CkC						4.0	3.0
CsF							
Dennis:							
DnB	35	60	35	70	4.0	7.0	6.5
DnC	30	50	30	65		6.5	5.5
DnC2	25		20	50		5.5	4.0
DxE							6.0
Hector:							
HeF						4.5	
HrC	15			25		4.5	3.0
HsF							
Kamie:							
KaE						4.5	
KfC	25			40		6.5	5.0
KfC2	20			30		4.5	4.0
KmD3						4.5	
Kanima: KnF						1.0	4.0
Kiomatia: Ko	25		25	45		6.0	4.0
Latanier: La	35	55	35	55	5.0	8.0	8.0
Linker: LnB	25	45	20	41		7.0	5.0
Lula: LuB	40	60	30	65	3.5	7.0	5.5
Mason: Ma	40	55	35	65	4.5	8.0	8.0
Moreland: Mo	15	30	30	40	3.5	5.5	6.0
Newtonia:							
NeB	40	60	30	70	4.0	6.5	6.5
NeC	35	50	25	55	4.0	6.5	6.0
NeC2	30		15	50		5.0	5.0
Okay:							
OaB	40	50	30	60	3.0	7.0	6.0
OaC	30	45	25	45		6.5	5.5
Okemah: OkA	40	60	35	70	4.0	7.0	6.5
Osage:							
Os	35	70	35	70	4.0	6.5	7.0
Oy	30	50	30	55	3.0	5.5	6.0
Parsons: PaA	35	55	30	55		6.5	6.0
Radley: Ra	40	70	35	70	4.5	8.0	8.0
Radley, channeled: Rc						7.0	7.0
Summit:							
SuB	35	60	30	65	4.0	6.0	6.0
SuC	30	55	25	60		5.5	5.5
Taloka:							
TaA	40	55	30	60		6.5	6.5
TaB	35	50	25	55		6.0	6.0
Tullahassee: Tu						8.0	6.5

[1] Animal-unit month—the amount of forage or feed required to maintain one animal unit—one cow, one horse, one mule, five sheep, or five goats—for a period of 30 days.

this, the soils are placed in 12 pasture and hayland suitability groups and each group is described. Those who wish to know the pasture and hayland suitability group of a soil can refer to the "Guide to Mapping Units" at the back of this survey. Those desiring detailed information about the management of soils can refer to the section "Descriptions of the Soils."

Much of the acreage in Wagoner County is in pasture. Pasture plants are grown on soils that range from Class I through Class VI. The trend is to convert cropland to pasture. Because of high land values, extensive acreages of Class IV and VI used for trees also are being cleared and planted to tame pasture plants.

The principal base grasses are improved bermudagrass for warm-season pasture and fescue and bromegrass for cool-season pasture. The base grass is usually overseeded on bermudagrass, provide grazing in late legume mixture is the main summer pasture vegetation. Improved varieties of bermudagrass under good management will produce more forage than common bermudagrass. Bermudagrass is well suited to most of the soils in Classes I through VI. Winter rye and vetch, overseeded on bermudagrass, provide grazing late in fall and early spring. Annual lespedeza is grown with bermudagrass mainly to provide more palatable forage in July and August. Sudan and sorghum hybrids are used for summer temporary pasture where perennial forages are in short supply. Fall-sown small grain such as winter rye is sometimes used for fall, winter, and spring grazing as a supplement to native and perennial tame pasture plants.

Tall fescue and bromegrass pasture plants also provide grazing early in spring and late in fall. Tall fescue is better suited to the wetter, clayey soils. Tall fescue can be grown successfully in soils on uplands, but intensive management is required if it is to survive dry seasons. On soils on flood plains, management need not be so intensive. Bromegrass is suited to the better drained soils on flood plains. Ladino and big-hop clovers are commonly grown with both fescue and bromegrass.

Proper grazing helps to lengthen the life of most pastures. Bromegrass grazed with other species is likely to be killed by excessive use, since it is more palatable than bermudagrass or fescue. Fescue and bromegrass pasture needs to remain idle in July and August. This rest permits the plants to grow enough to shade the ground and regain plant vigor.

Brush control is essential, especially in areas where trees are growing. Applying fertilizer provides for more vigorous plants and more palatable forage. This helps to increase production and lengthen the lifespan of the pasture. Some legumes, such as Ladino clover, require more phosphate and lime than such others as yellow-hop clover and lespedeza. Where grass is grown without legumes, larger amounts of nitrogren fertilizer are commonly needed.

PASTURE AND HAYLAND SUITABILITY GROUP 1A

In this group are deep, somewhat poorly drained soils on flood plains. These soils are subject to flooding. They are clayey throughout or have a clayey surface layer and a loamy subsoil. These soils are suited to tall fescue and bermudagrass. Protection from damaging floods, avoidance of surface compaction, and improvement of water intake are needed management practices on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 2A

In this group are deep, well drained or moderately well drained soils on flood plains and terraces. These soils are subject to flooding. They have a loamy surface layer and a loamy subsoil or loamy or sandy underlying material. They are suited to tall fescue and bermudagrass. Control of brush and protection from damaging floods are needed management practices on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 2B

In this group are deep, poorly drained or somewhat poorly drained soils on flood plains and terraces. These soils are subject to flooding. They have a loamy surface layer and a loamy or clayey subsoil or loamy underlying material. They are suited to tall fescue and bermudagrass. Control of brush, the use of drainage practices and fertilizers, prevention of surface compaction, and protection from damaging floods are needed management practices.

PASTURE AND HAYLAND SUITABILITY GROUP 3A

In this group are deep, well-drained soils on flood plains. These soils are subject to flooding. They have a loamy surface layer and sandy underlying material. They are suited to bermudagrass. They are not so well suited to tall fescue, but it can be grown under good management. Management practices that protect from damaging floods, decrease the hazard of erosion, and conserve moisture are needed on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 8A

In this group are deep or moderately deep, well drained, moderately well drained, or somewhat poorly drained soils on uplands. These soils have a loamy surface layer and a loamy or clayey subsoil or loamy underlying material. They are better suited to bermudagrass than to other pasture plants. They are not so well suited to tall fescue, but it can be grown under good management. Management practices that reduce the hazard of erosion, maintain or improve soil tilth, and prevent surface compaction are needed on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 8B

In this group are deep or moderately deep, well-drained soils on uplands. These soils are low in fertility. They have a loamy surface layer and a loamy or clayey subsoil. They are better suited to bermudagrass than to other pasture plants. They are not so well suited to tall fescue, but it can be grown under good management. Brush control and the split application of fertilizer are needed management practices on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 8C

In this group are deep, somewhat poorly drained soils on uplands. These soils have a loamy surface layer and a loamy and clayey subsoil. They are suited to bermudagrass and tall fescue. The use of drainage practices and prevention of surface compaction are needed management practices on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 8D

In this group are deep, poorly drained soils on uplands. These soils have a high content of exchangeable sodium. They have a loamy surface layer and a clayey subsoil. They are poorly suited to pasture plants because of their shallow root zone and droughty nature. Preparing a seedbed and getting a stand of grass is a problem because of the high sodium content and the presence of a surface crust after rains.

PASTURE AND HAYLAND SUITABILITY GROUP 8F

In this group are deep, well-drained soils on uplands. These soils are severely eroded or consist of soil material reworked after strip mining. They have a loamy or sandy surface layer and a loamy subsoil. They are suited to bermudagrass or weeping lovegrass. Production will be lower than that on better soils under the same management. Control of erosion and maintenance of vegetative cover are needed management practices on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 9A

In this group are deep, well-drained soils on uplands. These soils are low in fertility. They have a sandy surface layer and a loamy subsoil. They are suited to bermudagrass or weeping lovegrass. Control of brush, application of fertilizer, and protection from erosion are needed management practices on these soils.

PASTURE AND HAYLAND SUITABILITY GROUP 14A

In this group are shallow, well drained or somewhat excessively drained soils on uplands. These soils are loamy throughout. They are suited to bermudagrass and tall fescue. The shallowness of the soils in this group limits plant growth during dry periods. Management practices that control brush, conserve moisture, and protect the soils from erosion are needed on these soils.

Use of the Soils for Range [4]

This section contains information about the use of soils for range. Range in Wagoner County consists of native grassland prairies and savannah areas used mainly for grazing. It occupies about one-third of the total farmed soils in the county.

Range is generally used in conjunction with tame pasture and small grain, but a few large ranches do exist. The main livestock enterprise is the breeding and raising of beef cattle.

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amounts of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of rangeland that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community. It reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers, and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75, in fair condition if the percentage is 26 to 50, and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

One of the main objectives of good range management is to keep rangeland in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Description of range sites

In the following pages, the range sites of Wagoner County are described and the climax plants and prin-

[4] By DAVID ANKLE, range conservationist, Soil Conservation Service.

cipal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

CLAYPAN PRAIRIE RANGE SITE

This range site consists of deep, nearly level, loamy soils on uplands. These soils have a loamy and clayey subsoil that restricts the penetration of roots and water.

The approximate species composition, by weight, of the climax plant community is big bluestem, 30 percent; little bluestem and switchgrass, each 15 percent; indiangrass, 10 percent; tall dropseed, side-oats grama, Scribner panicum, Illinois bundleflower, prairie scurfpea, and woody plants, each 5 percent.

These soils produce approximately 4,500 pounds of air-dry herbage per acre in years having favorable growing conditions and 2,000 pounds per acre in years having poor growing conditions. Approximately 95 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, big bluestem, little bluestem, switchgrass, indiangrass, and Illinois bundleflower decrease in the plant community. Such plants as tall dropseed, side-oats grama, Scribner panicum, prairie scurfpea, winged elm, and hawthorn increase. If overgrazing is prolonged, ragweed, bitter sneezeweed, croton, splitbeard bluestem, broomsedge bluestem, annual bromes, and persimmon make up a substantial part of the range. Under these circumstances the total production is greatly reduced.

Range management practices practical on this site are proper grazing use, deferred grazing systems, stock-water development, range seeding, fencing, brush control, and weed control.

ERODED SANDY SAVANNAH RANGE SITE

This range site consists of deep, severely eroded, very gently sloping to sloping, sandy or loamy soils on uplands. These soils have a loamy subsoil. Production is low because of the thinner surface layer.

The approximate species composition, by weight, of the climax plant community is little bluestem, 35 percent; indiangrass, 15 percent; big bluestem, purpletop, and post oak, each 10 percent; switchgrass and blackjack oak, each 5 percent; Scribner panicum, 3 percent; red lovegrass, persimmon, and sassafras, each 2 percent; and hickory, 1 percent.

These soils produce approximately 2,500 pounds of air-dry herbage per acre in years having favorable growing conditions and 1,250 pounds per acre in years having poor growing conditions. Approximately 80 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, little bluestem, indiangrass, big bluestem, and switchgrass decrease in the plant community. Such plants as purpletop, Scribner panicum, red lovegrass, persimmon, sassafras, blackjack oak, post oak, and hickory increase. If overgrazing is prolonged, broomsedge and splitbeard bluestem, ragweeds, bitter sneezeweed, and annual three-awn make up a substantial part of the range, and total production is greatly reduced.

Range management practices practical on this site are proper grazing use, planned grazing systems, deferred grazing, range seeding, stock-water development, fencing, and brush control.

HEAVY BOTTOMLAND RANGE SITE

This range site consists of deep, nearly level, clayey or loamy soils on flood plains. These soils have a clayey subsoil.

The approximate species composition, by weight, of the climax plant community is prairie cordgrass, 30 percent; big bluestem, 20 percent; indiangrass and woody plants, each 10 percent; and switchgrass, little bluestem, tall dropseed, perennial sunflower, knotroot bristlegrass, and sedges, each 5 percent.

These soils produce approximately 7,000 pounds of air-dry herbage per acre in years having favorable growing conditions and 4,000 pounds per acre in years having poor growing conditions. Approximately 90 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, prairie cordgrass, big bluestem, indiangrass, switchgrass, and perennial sunflower decrease in the plant community. Such plants as little bluestem, tall dropseed, knotroot bristlegrass, sedges, ash, walnut, and pecan increase. If overgrazing is prolonged, giant ragweed, ironweed, white snakeroot, seacoast sumpweed, silver bluestem, windmillgrass, and hawthorn make up a substantial part of the range. Under these circumstances total production is greatly reduced.

Range management practices that are practical on this site are proper grazing use, deferred grazing, planned grazing systems, stock-water development, range seeding, fencing, brush control, and weed control.

LOAMY BOTTOMLAND RANGE SITE

This range site consists of deep, nearly level to gently sloping, loamy soils on flood plains and terraces. These soils have a loamy subsoil or loamy or sandy underlying material.

The approximate species composition, by weight, of the climax plant community is big bluestem, 25 percent; indiangrass, 20 percent; switchgrass, 15 percent; little bluestem, 10 percent; and eastern gamagrass, Florida paspalum, beaked panicum, combined sedges and rushes, compass plants, and woody plants, each 5 percent.

These soils produce approximately 10,000 pounds of air-dry herbage per acre in years having favorable growing conditions and 6,500 pounds per acre in years having poor growing conditions. Approximately 95 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, big bluestem, indiangrass, switchgrass, eastern gamagrass, Florida paspalum, and compass plant decrease in the plant community. Such plants as little bluestem, beaked panicum, sedges, rushes, pecan, walnut, and greenbrier increase. If overgrazing is prolonged, broomsedge bluestem, annual bromes, giant ragweed, seacoast sump-

weed, white snakeroot, persimmon, oak, and hawthorn make up a substantial part of the range, and total production is greatly reduced.

Range management practical on this site are proper grazing use, planned grazing systems, deferred grazing, stock-water development, cross fencing, range seeding, brush control, and weed control.

LOAMY PRAIRIE RANGE SITE

This range site consists of deep and moderately deep, nearly level to moderately steep, loamy soils on uplands. These soils have a loamy or clayey subsoil.

The approximate species composition, by weight, of the climax plant community is big bluestem, 35 percent; indiangrass, 15 percent; little bluestem and switchgrass, each 10 percent; and Scribner panicum, purpletop, tall dropseed, catclaw sensitivebrier, goldenrod, and woody plants, each 5 percent.

These soils produce approximately 7,000 pounds of air-dry herbage per acre in years having favorable growing conditions and 4,500 pounds per acre in years having poor growing conditions. Approximately 95 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, big bluestem, little bluestem, switchgrass, indiangrass, and catclaw sensitivebrier decrease in the plant community. Such plants as purpletops, tall dropseed, Scribner panicum, goldenrod, sumac, blackberry, coralberry, and indigobush increase. If overgrazing is prolonged, broomsedge bluestem, splitbeard bluestem, annual bromes, three-awn, common broomweed, ragweeds, ironweed, and persimmon make up a substantial part of the range, and total production is greatly reduced.

Range management practices that are practical on this site are proper grazing use, deferred grazing, planned grazing systems, stock-water development, brush control, fencing, weed control, and range seeding.

SANDY BOTTOMLAND RANGE SITE

This range site consists of deep, nearly level, loamy soils on flood plains. These soils have sandy underlying material, and they are subject to occasional flooding.

The approximate species composition, by weight, of the climax plant community is switchgrass and cottonwood, each 20 percent; big bluestem, indiangrass, and black willow, each 10 percent; little bluestem, beaked panicum, tall dropseed, purpletop, and combined Illinois bundleflower and tickclover, each 5 percent; sandplum, 3 percent; and wild grape, 2 percent.

These soils produce approximately 3,800 pounds of air-dry herbage per acre in years having favorable growing conditions and 1,900 pounds per acre in years having poor growing conditions. Approximately 65 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, switchgrass, big bluestem, indiangrass, Illinois bundleflower, tickclover, and wildgrape decrease in the plant community. Such plants as beaked panicum, tall dropseed, purpletop, black willow, cottonwood, and sand plum increase. If overgrazing is prolonged, bushy bluestem, sand dropseed, ironweed, wooly verbena, and saltcedar make up a substantial part of the range, and total production is greatly reduced.

Range management practices practical on this site are proper grazing use, planned grazing systems, deferred grazing, fencing, stock-water development, weed control, and brush control.

SANDY SAVANNAH RANGE SITE

This range site consists of deep and moderately deep, very gently sloping to steep, loamy and sandy soils on uplands. These soils have a loamy or clayey subsoil. They support an understory of tall and mid grasses and an overstory of post oak and blackjack oak.

The approximate species composition, by weight, of the climax plant community is little bluestem, 20 percent; big bluestem and woody plants, each 15 percent; indiangrass, 10 percent; and switchgrass, wildrye, purple lovegrass, Scribner panicum, purpletop, Virginia tephrosia, perennial sunflower, and goldenrod, each 5 percent.

These soils produce approximately 5,500 pounds of air-dry herbage per acre in years having favorable growing conditions and 3,500 pounds per acre in years having poor growing conditions. Approximately 85 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, little bluestem, big bluestem, indiangrass, switchgrass, wildrye, Virginia tephrosia, and perennial sunflower decrease in the plant community. Such plants as purple lovegrass, Scribner panicum, purpletop, goldenrod, post oak, blackjack oak, red oak, and hickory increase. If overgrazing is prolonged, fringeleaf paspalum, broomsedge bluestem, three-awn, showy partridgepea, ragweed, croton, persimmon, and hawthorns make up a substantial part of the range. Under these circumstances total production is greatly reduced.

Range management practices practical on this site are proper grazing use, planned grazing systems, deferred grazing, stock-water development (wells), controlled burning, fencing, brush control, range seeding, and weed control.

SAVANNAH BREAKS RANGE SITE

This range site consists of shallow, steep and very steep soils on uplands. These soils are loamy throughout. They support an understory of tall and mid grasses and an overstory of post oak and blackjack oak.

The approximate species composition, by weight, of the climax plant community is little bluestem, 20 percent; big bluestem, indiangrass, switchgrass, and other woody plants, each 10 percent; and Canada wildrye, purpletop, side-oats grama, Scribner panicum, poison ivy, perennial lespedezas, post oak, and blackjack oak, each 5 percent.

These soils produce approximately 3,500 pounds of air-dry herbage per acre in years having favorable growing conditions and 1,750 pounds per acre in years having poor growing conditions. Approximately 80 percent of this herbage is from plants that provide forage for cattle or sheep.

Under continued heavy grazing by cattle, little bluestem, big bluestem, indiangrass, switchgrass, Canada

wildrye, poison ivy, and perennial lespedezas decrease in the plant community. Such plants as purpletop, side-oats grama, Scribner panicum, post oak, blackjack oak, chittam, redbud, and greenbrier increase. If overgrazing is prolonged, broomsedge bluestem, annual bromes, three-awn, poverty oatgrass, ragweed, croton, and winged elm make a substantial part of the range. Under these circumstances total production is greatly reduced.

Range management practices practical on this site are proper grazing use, planned grazing systems, deferred grazing, and controlled burning.

SHALLOW CLAYPAN RANGE SITE

This range site consists of nearly level, deep, loamy soils on uplands. These soils have a clayey subsoil that somewhat restricts the penetration of grass roots and water.

The approximate species composition, by weight, of the climax plant community is little bluestem, 30 percent; indiangrass, blue grama, side-oats grama, and silver bluestem, each 10 percent; and prairie scurfpea, big bluestem, switchgrass, gayfeather, tall dropseed, and heath aster, each 5 percent.

These soils produce approximately 3,000 pounds of air-dry herbage per acre in years having favorable growing conditions and 1,500 pounds per acre in years having poor growing conditions. Approximately 100 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, little bluestem, big bluestem, indiangrass, switchgrass, and gayfeather decrease in the plant community. Such plants as blue grama, side-oats grama, tall dropseed, silver bluestem, prairie scurfpea, and heath aster increase. If overgrazing is prolonged, annual three-awn, poverty dropseed, ragweed, Texas croton, common broomweed, and bitter sneezeweed make up a substantial part of the range. Under these circumstances total production is greatly reduced.

Range management practices practical on this site are proper grazing use, deferred grazing, planned grazing systems, fencing, and stock-water development.

SHALLOW PRAIRIE RANGE SITE

This range site consists of shallow, very gently sloping to steep soils on uplands. These soils are loamy throughout. They are underlain by sandstone and shale.

The approximate species composition, by weight, of the climax plant community is little bluestem, 30 percent; big bluestem, 15 percent; indiangrass, switchgrass, and side-oats grama, each 10 percent; and longspike tridens, black sampson, heath aster, tall dropseed, and woody plants, each 5 percent.

These soils produce approximately 4,200 pounds of air-dry herbage per acre in years having favorable growing conditions and 2,800 pounds per acre in years having poor growing conditions. Approximately 95 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, little bluestem, big bluestem, indiangrass, switchgrass, black sampson, and prairie rose decrease in the plant community. Such plants as side-oats grama, longspike tridens, tall dropseed, heath aster, winged elm, sumac, and blackberry increase. If overgrazing is prolonged, broomsedge bluestem, windmillgrass, annual brome, annual three-awn, showy partridgepea, common broomweed, persimmon, and hawthorn make up a substantial part of the range. Under these circumstances total production is greatly reduced.

Range management practices practical on this site are proper grazing use, planned grazing systems, deferred grazing, stock-water development, fencing, range seeding, and weed control.

SHALLOW SAVANNAH RANGE SITE

This range site consists of shallow, very gently sloping to steep soils on uplands. These soils are loamy throughout. They support an understory of tall and mid grasses and an overstory of post oak and blackjack oak.

The approximate species composition, by weight, of the climax plant community is little bluestem, 25 percent; big bluestem, 15 percent; indiangrass, 10 percent; and Canada wildrye, tall dropseed, Scribner panicum, Virginia tephrosia, perennial sunflower, heath aster, wildindigo, post oak, blackjack oak, and other woody plants, each 5 percent.

These soils produce approximately 3,500 pounds of air-dry herbage per acre in years having favorable growing conditions and 2,000 pounds per acre in years having poor growing conditions. Approximately 85 percent of this herbage is from plants that furnish forage for cattle or sheep.

Under continued heavy grazing by cattle, little bluestem, big bluestem, indiangrass, Canada wildrye, Virginia tephrosia, perennial sunflower, poison ivy, and wild grape decrease in the plant community. Such plants as tall dropseed, Scribner panicum, heath aster, wildindigo, post oak, blackjack oak, red oak, hickory, and coralberry increase. If overgrazing is prolonged, splitbeard bluestem, broomsedge bluestem, poverty oatgrass, croton, ironweed, horseweed fleabane, persimmon, and winged elm make up a substantial part of the range. Under these circumstances the total production is greatly reduced.

Range management practices practical on this site are proper grazing use, deferred grazing, planned grazing systems, stock-water development, fencing, controlled burning, brush control, and weed control.

Use of the Soils for Trees [5]

This section gives information on tree suitability of the soils of Wagoner County. Cottonwood, willow, and pecan are dominant along the Arkansas River. Elm, ash, pecan, and pin oak are dominant along the Verdigris and Grand Rivers and their tributaries. Black walnut, hackberry, mulberry, sycamore, and cherry are among other species occurring along these rivers and their tributaries. Post oak, blackjack oak, hickory, and some northern red oak occur in those areas on uplands having trees. Cottonwood is being cut for pulpwood and

[5] By NORMAN E. SMOLA, woodland conservationist, Soil Conservation Service.

shipped out of the county for processing, as are most merchantable hardwood logs. One sawmill in the county saws rough lumber.

Trees presently occupy approximately 44,000 acres in Wagoner County. Except for their watershed, wildlife, and esthetic value, natural stands of trees in the county have only limited economic value.

Farmstead windbreaks, if properly designed and located, can control drifting of snow and keep snow out of farmyards. They also shelter the home and farmyard. A good farmstead windbreak adds to the value of a farm.

Belts of trees and shrubs are useful in screening unsightly areas. Properly planned trees and shrub screens reduce noise. Tree and shrub plantings add esthetic value to most areas and are a means of controlling soil erosion.

On most soils preparation for tree planting can be the same as for ordinary field crops. Even though many of the species used are native to this county, they are not found growing naturally on soils where trees are needed. They therefore need special care. When the hazard of erosion is not severe, the soil can be prepared far enough in advance so that it will have time to settle. Alfalfa and grass sod should be fallowed in the summer at least 1 year before planting, and cropland can be fall plowed in the fall. Adequate cover or crop residue should be maintained on soils that have a severe hazard of erosion. Cover crops protect the soil both before and after planting and also protect the young seedlings.

Careful planning is needed for every tree planting for it to be most effective. When choosing stock for planting, it is preferable to select species that grow best in the type of soil found at the planting location. The soils in Wagoner County that have similar characteristics affecting tree growth have been placed in tree suitability groups. The recommended trees and shrubs for each of these groups are included in their descriptions at the end of this section. Healthy seedlings should be purchased from reputable nurseries or other agencies. Planting should be done late in winter or early in spring. The seedlings should be protected from drying out while being planted, and the ground should be packed so it will be firm around the roots.

Young trees need considerable care if they are to survive and do well in most of the soils of Wagoner County. If rainfall is limited and irregular, weeds need to be controlled so they do not compete for moisture. This can be done by cultivation or by using chemical weed killers. Trees need to be protected from livestock and fire. Additional information on appropriate design for the desired purpose and planting and care of tree plantings is available from the Soil Conservation Service or from the State forester and extension forester serving the county.

The kind of soil and the soil-air-moisture relationship greatly influence the growth of trees in this area. Trees generally grow better in sandy loam than they do in material of other textures. Only fair to poor growth is made in clayey soils, because these soils absorb and release moisture too slowly. Deep soils are better suited to trees than shallow soils, because more moisture can be stored for use during droughty periods. Hardwoods require deeper soils than conifers, although conifers make their best growth in the soils that are better suited to farming.

Conifers such as pine and eastern redcedar grow slower at first than hardwoods, but their growth is likely to equal that of most hardwoods as the trees mature. Conifers surpass hardwoods in length of life and in overall effectiveness as a windbreak or screen.

Available water capacity and fertility of the soil, tree spacing, tree suitability to the soil, and care given to the tree all affect rate of growth.

The soils in Wagoner County have been placed in tree suitability groups. The soils in each group are similar in those characteristics that affect tree growth. To find the names of the soils in each group, refer to the Guide to Mapping Units at the back of this survey.

The following brief description of each tree suitability group lists the trees and shrubs suitable for planting in the soils of each group. Expressed in the tree suitability group description are estimated heights at age 20 for certain species recommended for planting.

TREE SUITABILITY GROUP 1

In this group are nearly level or gently sloping, deep, moderately well drained or well drained soils on flood plains and terraces. Water erosion is a hazard on the areas subject to flooding. Moisture competition from weeds and grasses is the principal hazard to the establishment of trees. Estimated heights, in feet, of trees at 20 years are 70 to 80 for cottonwood and 60 to 70 for sycamore.

Trees and shrubs suitable for planting are such conifers as loblolly pine, eastern redcedar, and Scotch pine; such broadleafs as green ash, bur oak, pecan, hackberry, water oak, sycamore, cottonwood, sweetgum, blackgum, black walnut, redbud, dogwood, magnolia, baldcypress, northern red oak, sugar maple, and chinquapin; and such shrubs as lilac, buttonbush, witch hazel, and American plum.

TREE SUITABILITY GROUP 2

In this group are nearly level, deep, somewhat poorly drained soils on flood plains. Water erosion is a hazard in areas subject to flooding. Competition for moisture from weeds and grasses is the principal hazard to the establishment of trees. Estimated heights, in feet, of trees at age 20 are 75 to 85 for cottonwood, 65 to 75 for sycamore, and 35 to 45 for pin oak.

Trees and shrubs suitable for planting are loblolly pine and other conifers; such broadleafs as green ash, bur oak, pecan, sycamore, cottonwood, sweetgum, and pin oak; and such shrubs as buttonbush and witch hazel.

TREE SUITABILITY GROUP 3

In this group are nearly level, deep, well-drained soils on flood plains. Water erosion is a hazard in areas subject to flooding. Competition for moisture from weeds and grass is the principal hazard to the establishment of trees. Estimated heights, in feet, of trees at age 20 are 70 to 80 for cottonwood and 60 to 70 for sycamore.

Trees and shrubs suitable for planting are such conifers as ponderosa pine, Scotch pine, shortleaf pine, Austrian pine, and eastern redcedar; such medium to tall broadleafs as cottonwood, sycamore, bur oak, northern red oak, black oak, green ash, redbud, and dogwood; and such shrubs as American plum, lilac, tamarisk, and autumn-olive.

TREE SUITABILITY GROUP 4

In this group are nearly level, deep, somewhat poorly drained or poorly drained soils on flood plains. Periodic drought and competition for moisture from weeds and grasses are the principal hazards to the establishment of trees. Estimated heights, in feet, of trees at age 20 are 70 to 80 for cottonwood, 35 to 45 for water oak, and 35 to 45 for green ash.

Trees and shrubs suitable for planting are loblolly pine and other conifers; such medium to tall broadleafs as green ash, bur oak, pecan, hackberry, water oak, willow oak, cottonwood, sweetgum, dogwood, baldcypress, silver maple, and blackgum; and such shrubs as buttonbush and witch hazel.

TREE SUITABILITY GROUP 5

In this group are very gently sloping to moderately steep; shallow, moderately deep, or deep; well-drained soils on uplands. Water erosion is a hazard in areas where slopes are more than 3 percent. Competition for moisture from weeds and grasses is the principal hazard to the establishment of trees. Estimated heights, in feet, of trees at 20 years are 30 to 40 for shortleaf pine, 20 to 30 for eastern redcedar, and 25 to 35 for northern red oak.

Trees and shrubs suitable for planting are such conifers as shortleaf pine, eastern redcedar, and Scotch pine; such broadleafs as northern red oak, black hickory, post oak, black oak, chinquapin, osageorange, mulberry, redbud, dogwood, persimmon, sassafras, and magnolia; and such shrubs as American plum, lilac, sumac, those of the crataegus species, and autumn-olive.

TREE SUITABILITY GROUP 6

In this group are very gently sloping to very steep; shallow, moderately deep, and deep; well drained to somewhat excessively drained soils on uplands. Water erosion is a hazard in areas where slopes are more than 3 percent. Competition for moisture from weeds and grasses and soil droughtiness are the principal hazards to the establishment of trees in normal years. These soils cannot be safely cultivated. Estimated heights, in feet, of trees at age 20 are 30 to 40 for shortleaf pine, 20 to 30 for eastern redcedar, and 25 to 35 for northern red oak.

Trees and shrubs suitable for planting are such conifers as shortleaf pine and eastern redcedar; such broadleafs as northern red oak, black hickory, black locust, post oak, black oak, and chinquapin oak; and such shrubs as those of crataegus species and sumac.

TREE SUITABILITY GROUP 7

In this group are nearly level to steep, deep and moderately deep, well-drained soils on uplands. Water erosion is a hazard in areas where slopes are more than 3 percent. Periodic drought and competition for moisture from weeds and grasses are the principal hazards to the establishment of trees. Estimated heights, in feet, of trees at age 20 are 30 to 40 for shortleaf pine, 25 to 35 for eastern redcedar, and 25 to 35 for northern red oak.

Trees and shrubs suitable for planting are such conifers as shortleaf pine, loblolly pine, and eastern redcedar; such broadleafs as northern red oak, black hickory, black oak, chinquapin oak, osageorange, mulberry, redbud, dogwood, persimmon, sassafras, hackberry, green ash, magnolia, and silver maple; and such shrubs as American plum, lilac, sumac, and autumn-olive.

TREE SUITABILITY GROUP 8

In this group are nearly level to moderately steep, deep, somewhat poorly drained or moderately well drained soils on uplands and flood plains. Water erosion is a hazard in areas where slopes are more than 3 percent. Drought and moisture competition from weeds and grasses are the principal hazards to the establishment of trees. The clayey subsoil makes tree establishment difficult unless extra water is supplied during droughty periods. Data are insufficient to estimate expected tree heights.

Trees and shrubs suitable for planting are such conifers as loblolly pine, shortleaf pine, and eastern redcedar; such broadleafs as northern red oak, black hickory, black oak, chinquapin oak, osageorange, redbud, persimmon, sassafras, soapberry, and mulberry; and such shrubs as American plum, lilac, and sumac.

TREE SUITABILITY GROUP 9

In this group are gently sloping to very steep, deep, well-drained soils on uplands. These soils consist of material resulting from strip mining operations. Soil droughtiness is a hazard to the establishment of trees. Data are insufficient to estimate expected tree heights.

Trees and shrubs suitable for planting are such conifers as loblolly pine, shortleaf pine, and eastern redcedar; such broadleafs as black locust, sycamore, osageorange, and post oak; and such shrubs as sumac and those of the crataegus species.

TREE SUITABILITY GROUP 10

In this group are soils generally not suited to the planting of trees.

Use of the Soils for Wildlife Habitat [6]

Soils directly influence kinds and amounts of vegetation and amounts of water available, and in this way indirectly influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are thickness of soil useful to crops, texture of surface layer, available water capacity to a depth of 40 inches, wetness, surface stoniness or rockiness, hazard of flooding, slope, and permeability of the soil to air and water.

In table 3 soils of this survey area are rated according

[6] By GARY L. BULLARD and JEROME F. SYKORA, biologists, Soil Conservation Service.

TABLE 3.—*Potential of the soils for elements of wildlife habitat and kinds of wildlife*

Soil series and map symbol	Potential for elements of wildlife habitat—							Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow-water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Barge: BaF	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Bates: BbB, BbC, BbC2.	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Bonn, clayey subsoil variant: Bv	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Catoosa: CcD [1]	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Choska: Cd	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Choteau: ChB	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Coweta:										
CkC [1]	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
CsF	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Dennis:										
DnB	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
DnC, DnC2	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
DxE [1]	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Enders [2]	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Hector:										
HrC [1]	Very poor.	Poor	Poor	Very poor.	Very poor.	Poor	Very poor.	Poor	Very poor.	Very poor.
HsF	Very poor.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Poor	Very poor.
Kamie:										
KaE	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
KfC, KfC2	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
KmD3	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Kanima: KnF	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
Kiomatia: Ko	Fair	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
Latanier: La	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Fair.
Linker: LnB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Lula: LuB	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Mason: Ma	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Moreland: Mo	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Fair.
Newtonia: NeB, NeC, NeC2.	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Okay: OaB, OaC	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Okemah: OkA	Good	Good	Good	Good	Good	Poor	Good	Good	Good	Fair.
Osage:										
Os	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Oy	Poor	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.

TABLE 3.—*Potential of the soils for elements of wildlife habitat and kinds of wildlife*—Continued

Soil series and map symbol	Potential for elements of wildlife habitat—							Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow-water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Parsons: PoA	Fair	Good	Good	Good	Good	Fair	Good	Good	Good	Good.
Radley: Ra	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Radley, channeled: Rc.	Poor	Fair	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
Summit:										
SuB	Fair	Fair	Fair	Good	Good	Fair	Poor	Fair	Good	Poor.
SuC	Fair	Fair	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Taloka:										
TaA	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
TaB	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
Tullahassee: Tu	Poor	Fair	Fair	Good	Good	Fair	Poor	Fair	Good	Poor.

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or of one kind of soil and a land type. The other soil series or the land type in each case is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.

[2] Mapped only with Hector soils (HeF) in this county.

to their suitability for producing various kinds of plants and other elements that make up wildlife habitat. Seven elements of wildlife habitat and three groups, or kinds of wildlife have been rated. The ratings indicate relative suitability for various elements. They take into account mainly the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason, selection of a site for development as a habitat for wildlife requires inspection at the site. Ratings are defined in the following paragraphs.

A rating of *good* means the element of wildlife habitat and habitats generally are easily created, improved, and maintained. Few or no limitations affect management in this category, and satisfactory results are expected when the soil is used for the prescribed purpose.

A rating of *fair* means the element of wildlife habitat and habitats can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention may be required, however, for satisfactory results.

A rating of *poor* means the element of wildlife and limitations for the designated use are rather severe. Habitats can be created, improved, or maintained in most places, but management is difficult and requires intensive effort.

A rating of *very poor* means the elements of wildlife habitat are very severe and that unsatisfactory results are to be expected. It is either impossible or impractical to create, improve, or maintain habitats on soils in this category.

The significance of each subheading in table 3 under "Elements of Wildlife Habitat" and "Kinds of Wildlife" is given in the following paragraphs.

Grain and seed crops are annual grain-producing plants, such as corn, sorghum, wheat, and soybeans.

Grasses and legumes are domestic grasses and legumes that are established by planting. They provide food and cover for wildlife. Grasses include bahiagrass, ryegrass, and panicgrass; legumes include annual lespedeza, shrub lespedeza, and other clovers.

Wild herbaceous plants are native or introduced perennial grasses, forbs, and weeds that provide food and cover for wildlife. Beggarweed, perennial lespedeza, wild bean, pokeweed, and cheatgrass are typical examples. On rangeland, typical plants are bluestem, grama, perennial forbs, and legumes.

Hardwoods are nonconiferous trees, shrubs, and woody vines that produce wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be planted and developed through wildlife management programs. Typical species in this category are oak, beech, cherry, dogwood, maple, viburnum, grape, honeysuckle, greenbrier, and silverberry.

Coniferous woody plants commonly are cone-bearing trees and shrubs that provide cover and furnish food in the form of browse, seeds, or fruitlike cones. They commonly grow in their natural environment, but they may be planted and managed. Typical plants in this category are pines, cedars, and ornamental trees and shrubs.

Wetland plants are annual and perennial herbaceous plants that grow wild on moist and wet sites. They furnish food and cover mostly for wetland wildlife. Typical examples of plants are smartweed, wild millet, spikerush and other rushes, sedges, burreed, tearthumb, and aneilema. Submerged and floating aquatics are not included in this category.

Shallow-water areas are impoundments or excavations for controlling water, generally not more than 5 feet deep, that are suitable for waterfowl habitat. Some are designed to be drained, planted, and then flooded;

others are permanent impoundments that grow submerged aquatics.

In table 3 the soils are rated according to their suitability as habitat for the three kinds of wildlife in the county—open land, woodland, and wetland. These ratings are related to ratings made for the elements of habitat. For example, soils rated very poor for shallow-water developments are rated very poor for wetland wildlife.

Open-land wildlife are birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, doves, meadowlarks, field sparrows, cottontail rabbits, and foxes are typical examples of open-land wildlife.

Woodland wildlife are birds and mammals that normally live in wooded areas of hardwood trees, coniferous trees, and shrubs. Woodcocks, thrushes, wild turkeys, vireos, deer, squirrels, and raccoons are typical examples of woodland wildlife.

Wetland wildlife are birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, shore birds, herons, minks, and muskrats are typical examples of wetland wildlife.

Use of the Soils for Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 4 the soils of Wagoner County are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 4 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome

TABLE 4.—*Limitations of the soils for recreational development*

[Soil characteristics in this table are expressed in computer-adapted terms differing from those in the Soil Survey Manual. Refer to Explanation of Key Phrases, page 65, for definition of "percs slowly" and other terms that describe soil characteristics]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Barge: BaF	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Bates:				
BbB	Slight	Slight	Slight	Slight.
BbC, BbC2	Slight	Slight	Moderate: slope	Slight.
Bonn, clayey subsoil variant: Bv.	Severe: wet; percs slowly.	Severe: wet	Severe: wet; percs slowly.	Severe: wet.
Catoosa: CcD [1]	Slight	Slight	Severe: slope	Slight.
Choska: Cd	Moderate: floods	Slight	Moderate: floods	Slight.
Choteau: ChB	Moderate: percs slowly.	Slight	Moderate: percs slowly; wet.	Slight.
Coweta:				
CkC [1]	Slight	Slight	Severe: depth to rock	Slight.
CsF	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Dennis:				
DnB, DnC, DnC2	Moderate: wet; percs slowly.	Slight	Moderate: wet; percs slowly.	Slight.
DxE [1]	Moderate: wet; percs slowly; slope.	Moderate: slope	Severe: slope	Slight.
Enders [2]	Severe: percs slowly; slope.	Severe: slope	Severe: slope; percs slowly.	Severe: slope.
Hector:				
HeF, HsF	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
HrC	Slight	Slight	Severe: depth to rock	Slight.
Kamie:				
KaE	Severe: slope	Severe: slope	Severe: slope	Moderate: slope; too sandy.
KfC, KfC2	Slight	Slight	Moderate: slope	Slight.
KmD3	Slight	Slight	Severe: slope	Slight.
Kanima: KnF	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Kiomatia: Ko	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Latanier: La	Severe: too clayey; wet; floods; percs slowly.	Severe: too clayey	Severe: too clayey; percs slowly.	Severe: too clayey.
Linker: LnB	Slight	Slight	Moderate: depth to rock; slope.	Slight.

TABLE 4.—*Limitations of the soils for recreational development*—Continued

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lula: LuB	Slight	Slight	Moderate: slope	Slight.
Mason: Ma	Severe: floods	Slight	Moderate: floods	Slight.
Moreland: Mo	Severe: percs slowly; wet; too clayey; floods.	Severe: too clayey; wet.	Severe: percs slowly; wet; too clayey.	Severe: too clayey; wet.
Newtonia: NeB, NeC, NeC2.	Slight	Slight	Moderate: slope	Slight.
Okay: OaB, OaC	Slight	Slight	Moderate: slope	Slight.
Okemah: OkA	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Osage:				
Os	Severe: floods; percs slowly; wet.	Severe: floods; wet	Severe: wet; percs slowly.	Severe: wet.
Oy	Severe: floods; percs slowly; wet.	Severe: wet; floods; too clayey.	Severe: wet; floods; percs slowly; too clayey.	Severe: wet; too clayey.
Parsons: PaA	Severe: percs slowly; wet.	Severe: wet	Severe: wet; percs slowly.	Severe: wet.
Radley:				
Ra	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Channeled: Rc	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Summit: SuB, SuC	Moderate: percs slowly; too clayey.	Moderate: too clayey	Moderate: percs slowly; too clayey.	Moderate: too clayey.
Taloka: TaA, TaB	Severe: wet; percs slowly.	Moderate: wet	Severe: wet; percs slowly.	Moderate: wet.
Tullahassee: Tu	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or of one kind of soil and a land type. The other soil series in each case or the land type is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.

[2] Mapped only with Hector soils (HeF) in this county.

or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these, is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry and are not susceptible to flooding during the season of use. They do not have slopes or stoniness that greatly increase cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need be able to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, have good drainage, and are not susceptible to flooding during periods of heavy use. Their surface is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained and are firm when wet but not dusty when dry. They are flooded no more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils [7]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can

[7] ROBERT E. HEIDLAGE, engineer, assisted in the preparation of this section.

benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degress and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternative routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5 and 6, which show several estimated soil properties significant to engineering, and in tables 7, 8, 9, and 10, which show interpretations for various engineering uses. This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 7, 8, 9, and 10. It can also be used to make other useful maps.

The information in this section does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 72 inches. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists that is not known to all engineers. Many of these terms commonly used in soil science are defined in the Glossary.

Engineering Classification Systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system,[8] used by the SCS engineers, Department of Defense, and others and the AASHO system,[9] adopted by the American Association of State Highway Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and content of organic matter. Soils are grouped in 15 classes—there are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups, ranging from A-1 to A-7, on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clayey soils that have low strength when wet and that are the poorest soils for subgrade. The AASHO estimated classification is given in table 5 for all soils mapped in the county.

Soil Properties Significant in Engineering

Several estimated soil properties and characteristics significant in engineering are given in tables 5 and 6. These estimates are made for typical soil profiles, for the whole soil, and by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. In the following paragraphs are explanations of some of the columns in table 5.

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms take into account the percentage of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid

[8] United States Department of Defense, Unified Soil Classification System for Roads, Airfields, Embankments and Foundations. MIL-STD-619B, 30 pp., illus., 1968.

[9] American Association of State Highway Officials, Standard Specifications for Highway Materials and Methods of Sampling and Testing. Ed. 8, 2 v., illus., 1961.

state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5.

Table 6 contains information on the estimated engineering properties of the soils. Following are explanations of some of the terms used in that table.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 6

TABLE 5.—*Estimated physical properties of the soils*

[Absence of data indicates that no estimate was made. The symbol < means less than]

Soil series and map symbols	Depth from surface	USDA texture	Classification		More than 3 inches	Soil material passing sieve—				Liquid limit	Plasticity index
			Unified	AASHO		No. 4	No. 10	No. 40	No. 200		
	In				*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	
Barge: BaF	0–72	Silty clay loam, clay loam.	CL	A–6, A–7	0	100	100	96–100	75–98	33–45	13–24
Bates: BbB, BbC, BbC2.	0–14	Fine sandy loam	ML, CL–ML	A–4	0	100	98–100	94–100	51–85	20–35	3–10
	14–19	Loam, clay loam	CL, ML	A–4, A–6	0	100	100	90–100	65–90	25–40	8–20
	19–32	Clay loam, sandy clay loam.	CL	A–4, A–6	0	100	100	90–100	65–90	25–40	8–20
	32	Sandstone.									
Bonn, clayey subsoil variant: Bv.	0–4	Silt loam	ML, CL–ML, CL	A–4	0	100	100	96–100	80–97	24–30	1–10
	4–60	Clay	CL, CH	A–7	0	100	100	96–100	90–95	45–65	20–35
Catoosa: CcD.[1]	0–7	Silt loam	ML	A–4	0	100	100	96–100	80–90	24–35	2–10
	7–12	Silt loam, silty clay loam.	CL, ML	A–4, A–6	0	100	100	96–100	85–95	24–40	8–20
	12–28	Silty clay loam, clay loam.	CL	A–6	0	100	100	96–100	85–95	35–40	11–25
	28	Limestone.									
Choska: Cd	0–14	Silt loam	CL, CL–ML, ML	A–4	0	100	100	96–100	80–97	24–35	2–10
	14–48	Silt loam, very fine sandy loam.	ML, CL–ML, CL	A–4	0	100	100	90–100	50–85	<30	NP–8
	48–66	Loamy fine sand	SM	A–2	0	100	98–100	90–100	15–35		NP
Choteau: ChB.	0–24	Silt loam	CL, CL–ML, ML	A–4, A–6	0	100	100	96–100	75–90	24–35	1–12
	24–30	Silty clay loam, clay loam.	CL	A–6, A–7	0	100	100	96–100	85–95	38–50	13–26
	30–65	Silty clay loam, silty clay, clay, clay loam.	CL, CH	A–6, A–7	0	100	100	96–100	90–98	40–60	18–35
Coweta: CkC,[1] CsF.	0–8	Loam, fine sandy loam.	ML, CL CL–ML, SM–SC, SM	A–4	0–20	90–100	90–100	85–95	36–75	<30	NP–10
	8–15	Fine sandy loam, loam, clay loam.	ML, CL–ML, CL, SM–SC, SM, GM, GM–GC, GC	A–4, A–6	0–15	60–70	60–70	60–70	25–60	<35	NP–20
	15	Sandstone and shale.									
Dennis: DnB, DnC, DnC2, DxE.[1]	0–16	Silt loam	ML, CL–ML, CL	A–4, A–6	0	100	100	96–100	80–97	24–33	1–12
	16–24	Silty clay loam, clay loam.	CL	A–6, A–7	0	100	100	96–100	75–98	33–50	13–26
	24–64	Silty clay loam, clay loam, clay.	CL, CH	A–6, A–7	0	100	100	96–100	75–98	33–55	13–35

TABLE 5.—*Estimated physical properties of the soils*—Continued

Soil series and map symbols	Depth from surface	USDA texture	Classification		More than 3 inches	Soil material passing sieve—				Liquid limit	Plasticity index
			Unified	AASHO		No. 4	No. 10	No. 40	No. 200		
	In				*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	
Enders [2]	0–5	Gravelly fine sandy loam.	ML, CL–ML, CL	A–4	0	80–100	80–97	75–90	50–70	<30	NP–8
	5–11	Clay loam, silty clay loam, loam.	CL, ML	A–6	0	80–100	80–100	80–100	75–95	30–40	11–15
	11–38	Silty clay, clay	MH, CH	A–7	0	95–100	90–100	85–100	85–95	45–70	20–38
	38–44	Soft weathered shale.									
Hector: HeF, HrC, [1] HsF.	0–16	Fine sandy loam, gravelly fine sandy loam.	SM, SM–SC, ML, CL–ML	A–2, A–4	0–25	85–100	80–100	75–100	30–65	<26	NP–6
	16	Sandstone.									
Kamie: KaE, KfC, KfC2, KmD3.	0–18	Loamy fine sand, fine sandy loam.	SM, SM–SC, ML, CL–ML	A–4	0	100	98–100	94–100	36–60	<26	NP–6
	18–56	Sandy clay loam, clay loam.	SC, CL	A–4, A–6	0	100	100	90–100	36–80	25–40	8–20
	56–70	Fine sandy loam, sandy clay loam.	SM, SM–SC, SC, ML, CL–ML, CL	A–4, A–6	0	100	98–100	90–100	36–65	<35	NP–14
Kanima: KnF	0–4	Shaly silty clay loam, very shaly clay loam.	GM, GC, SM, SC, CL, GP–GM, GP–GC	A–1, A–2, A–4, A–6	0–5	10–80	7–78	7–78	5–80	20–49	1–25
	4–72	Very shaly silty clay loam.	GP, GM, GC, SP, SM, SC, CL	A–1, A–2, A–4, A–6	5–30	10–54	3–54	3–54	3–54	20–49	1–25
Kiomatia: Ko	0–18	Fine sandy loam.	SM	A–4	0	100	98–100	90–100	36–45	<26	NP–4
	18–56	Loamy fine sand, fine sand.	SP–SM, SM, SM–SC	A–2	0	100	98–100	80–90	11–35	<22	NP–4
Latanier: La	0–24	Clay	CH	A–7	0	100	100	100	95–100	50–65	25–40
	24–64	Silt loam, very fine silt loam.	ML, CL–ML, CL	A–4, A–6	0	100	100	94–100	80–100	<30	NP–12
Linker: LnB	0–13	Fine sandy loam.	SM, SM–SC, SC, ML, CL–ML, CL	A–4	0	100	98–100	94–100	36–60	<30	NP–10
	13–16	Fine sandy loam, sandy clay loam.	SM, SM–SC, SC, ML, CL–ML, CL	A–4, A–6	0	100	98–100	90–100	36–65	<37	NP–18
	16–28	Sandy clay loam, clay loam.	SM, SM–SC, SC, ML, CL–ML, CL	A–4, A–6	0	100	90–100	90–100	36–80	<37	NP–18
	28–34	Sandy loam, sandy clay loam.	SM, SM–SC, SC, ML, CL–ML, CL	A–4, A–6	0	95–100	90–100	90–100	40–65	<37	NP–16
	34	Sandstone.									

TABLE 5.—*Estimated physical properties of the soils*—Continued

Soil series and map symbols	Depth from surface	USDA texture	Classification		More than 3 inches	Soil material passing sieve—				Liquid limit	Plasticity index
			Unified	AASHO		No. 4	No. 10	No. 40	No. 200		
	In				*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	
Lula: LuB	0–10	Silt loam	CL, CL–ML, ML	A–4	0	100	100	96–100	80–97	22–37	2–8
	10–18	Silt loam, clay loam, silty clay loam.	CL, ML	A–4, A–6, A–7	0	100	100	96–100	65–98	30–43	9–20
	18–52	Silty clay loam, clay.	CL, ML	A–6, A–7	0	95–100	95–100	96–100	75–98	33–55	13–26
	52	Limestone.									
Mason: Ma	0–34	Silt loam	ML, CL–ML, CL	A–4	0	100	100	90–100	75–90	24–35	3–10
	34–52	Clay loam	CL	A–6, A–7	0	100	100	96–100	80–90	34–43	13–20
	52–60	Loam, clay loam.	CL, ML	A–4, A–6, A–7	0	100	100	96–100	65–90	30–43	9–20
Moreland: Mo	0–56	Clay	CH	A–7	0	100	98–100	98–100	95–100	50–65	27–40
Newtonia: NeB, NeC, NeC2.	0–14	Silt loam	ML, CL–ML, CL	A–4	0	100	100	96–100	80–97	22–31	2–8
	14–22	Silt loam, silty clay loam.	CL, ML	A–4, A–6, A–7	0	100	100	96–100	80–98	30–43	8–19
	22–60	Silty clay loam	CL	A–6, A–7	0	100	100	98–100	90–98	33–42	12–19
	60–80	Silty clay, silty clay loam, clay.	CH, CL	A–7, A–6	0	100	100	96–100	90–99	41–65	18–35
Okay: OoB, OaC.	0–13	Loam	CL, CL–ML, ML	A–4	0	100	100	96–100	65–85	22–31	3–10
	13–40	Loam, clay loam, silty clay loam.	SM–SC, SC, ML, CL–ML, CL	A–4, A–6	0	100	100	90–100	36–90	25–40	7–18
	40–66	Fine sandy loam, sandy clay loam.	SM, SM–SC, SC, ML, CL–ML, CL	A–4, A–6	0	100	98–100	90–100	36–90	<34	NP–13
Okemah: OkA	0–23	Silt loam	CL, CL–ML, ML	A–4, A–6	0	100	100	96–100	80–97	21–37	1–12
	23–66	Silty clay, clay	CL, CH	A–7	0	100	100	98–100	90–99	41–65	18–35
Osage:											
Os	0–18	Silty clay loam	CL, CH	A–7, A–6	0	100	100	98–100	90–98	33–42	12–19
	18–66	Clay, silty clay	CL, CH	A–7	0	100	100	96–100	90–95	55–65	30–45
Oy	0–66	Clay, silty clay	CL, CH	A–7	0	100	100	96–100	90–95	55–65	30–45
Parsons: PoA	0–12	Silt loam	ML, CL–ML, CL	A–4, A–6	0	100	96–100	96–100	75–90	20–35	1–12
	12–80	Clay, silty clay loam, silty clay.	CL, CH	A–7	0	100	94–100	94–100	90–98	41–65	20–40
Radley: Ra, Rc.	0–66	Silt loam, silty clay loam.	ML, CL	A–4, A–6	0	100	100	96–100	80–90	30–40	8–18
Rock outcrop [3] Too variable to rate.											
Summit: SuB, SuC.	0–12	Silty clay loam	CL	A–6, A–7	0	100	100	98–100	90–98	37–50	15–25
	12–16	Silty clay loam, clay, silty clay.	CL, CH, MH	A–6, A–7	0	100	100	96–100	80–99	35–65	20–35
	16–40	Clay, silty clay	CH, MH, CL	A–7	0	98–100	98–100	96–100	80–98	41–70	25–40
	40–60	Clay	CH, MH, CL	A–7	0	95–100	95–100	94–100	80–98	41–70	25–40

TABLE 5.—*Estimated physical properties of the soils—Continued*

Soil series and map symbols	Depth from surface	USDA texture	Classification		More than 3 inches	Soil material passing sieve—				Liquid limit	Plasticity index
			Unified	AASHO		No. 4	No. 10	No. 40	No. 200		
	In				*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*	
Taloka: TaA, TaB.	0–28	Silt loam	ML, CL–ML, CL	A–4, A–6	0	100	96–100	96–100	75–90	20–35	1–12
	28–78	Silty clay loam, silty clay, clay, clay loam.	CL, CH	A–6, A–7	0	100	94–100	94–100	90–98	35–65	20–40
Tullahassee: Tu.	0–16	Fine sandy loam.	SM, SM–SC, ML, CL–ML, CL	A–4	0	100	98–100	94–100	36–60	<30	NP–10
	16–64	Fine sandy loam, loam.	SM, SM–SC, ML, CL–ML, CL	A–4	0	100	98–100	94–100	36–85	<30	NP–10

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or of one kind of soil and a land type. The other soil series in each case or the land type is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.
[2] Mapped only with Hector soils (HeF) in this county.
[3] Mapped only with Catoosa soils (CcD) in this county.

do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soil to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crops.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH values and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the change in the volume of soil material when the content of moisture changes. It is the extent to which the soil shrinks as it dries out or swells when it gets wet. This shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 6, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but it is also influenced by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage and that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations

The interpretations in tables 7, 8, 9, and 10 are based on the estimated engineering properties of soils shown in tables 5 and 6 and on the experiences of engineers and soil scientists with the soils of Wagoner County. In tables 7, 8, and 9, ratings are shown of the limitations or suitabilities of the soils for all specified listed purposes. Table 10 lists the features that affect the planning, installation, and maintenance of drainage systems for crops and pasture, irrigation systems, terraces, and diversions.

Soil limitations are indicated by the ratings slight, moderate, and severe. A rating of *slight* means that the soil properties are generally favorable for the rated use and that any limitations are minor and easily overcome. A rating of *moderate* means that some soil properties are unfavorable for the rated use but can be overcome or modified by special planning and design. A rating of *severe* means that the soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms for limitations of slight, moderate, and severe. In addition, the term *unsuited* is used for soils that have no potential as a source of sand or gravel.

Interpretations of soil for sanitary facilities.—Table 7 contains information on the suitability of the soils for sanitary facilities. Following are explanations of some of the terms used in that table.

Septic-tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 72 inches is evaluated for this use. The soil properties considered are those that affect both the absorption of effluent and the construction and

TABLE 6.—*Estimated engineering properties*

[The symbol > means more than, and the symbol < means less than]

Soil series and map symbols	Depth to—		Depth from surface	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
	Bedrock	Water table						Steel	Concrete
	Inches	*Feet*	*Inches*	*Inches per hour*	*Inches per inch of soil*	*pH*			
Barge: BaF	>60	>6	0–72	0.2–0.6	0.15–0.22	6.1–7.8	Moderate	Moderate	Low.
Bates: BbB, BbC, BbC2.	20–40	>6	0–14	0.6–2.0	0.11–0.15	5.1–6.0	Low	Low	Moderate.
			14–19	0.6–2.0	0.16–0.18	5.1–6.5	Low	Low	Moderate.
			19–32	0.6–2.0	0.17–0.19	5.1–6.0	Moderate	Low	Moderate.
			32						
Bonn, clayey subsoil variant: Bv	>60	0–0.5	0–4	0.2–0.6	0.16–0.24	5.1–7.3	Low	High	Moderate.
			4–60	<0.06	0.12–0.18	6.6–7.8	High	High	Low.
Catoosa: CcD [1]	20–40	>6	0–7	0.6–2.0	0.16–0.24	5.6–6.5	Low	Low	Low.
			7–12	0.6–2.0	0.15–0.19	5.6–6.5	Moderate	Moderate	Low.
			12–28	0.6–2.0	0.15–0.19	5.6–6.5	Moderate	Moderate	Low.
			28						
Choska: Cd	>60	>6	0–14	0.6–2.0	0.16–0.24	6.1–7.8	Low	Low	Low.
			14–48	0.6–2.0	0.13–0.24	6.6–8.4	Low	Low	Low.
			48–66	2.0–6.0	0.07–0.11	7.9–8.4	Low	Low	Low.
Choteau: ChB	>60	2–3	0–24	0.6–2.0	0.15–0.21	4.5–6.5	Low	Moderate	Moderate.
			24–30	0.2–0.6	0.15–0.22	4.5–6.0	Moderate	High	Moderate.
			30–65	0.06–.20	0.14–0.18	5.1–7.8	High	High	Low.
Coweta: CkC, [1] CsF	10–20	>6	0–8	2.0–6.0	0.09–0.16	5.1–6.5	Low	Low	Moderate.
			8–15	0.6–2.0	0.09–0.18	5.1–6.5	Low	Low	Moderate.
			15						
Dennis: DnB, DnC, DnC2, DxE. [1]	>60	2–3	0–16	0.6–2.0	0.15–0.21	5.1–6.0	Low	Moderate	Moderate.
			16–24	0.2–0.6	0.18–0.22	4.5–6.0	Moderate	Moderate	Moderate.
			24–64	0.06–0.2	0.14–0.22	5.1–6.5	High	High	Moderate.
Enders [2]	40–60	>6	0–5	0.6–2.0	0.07–0.15	4.1–5.5	Low	Low	Moderate.
			5–11	0.2–0.6	0.10–0.20	4.1–5.5	Low	Moderate	High.
			11–38	<0.06	0.17–0.20	4.1–5.5	High	High	High.
			38–44						
Hector: HeF, HrC, [1] HsF.	10–20	>6	0–16	2.0–6.0	0.05–0.14	5.1–6.5	Low	Low	Moderate.
			16						
Kamie: KaE, KfC, KfC2, KmD3.	>60	>6	0–18	2.0–6.0	0.11–0.15	5.6–7.3	Low	Low	Moderate.
			18–56	0.6–2.0	0.12–0.20	4.5–6.0	Low	Moderate	High.
			56–70	0.6–2.0	0.11–0.17	4.5–6.0	Low	Moderate	High.
Kanima: KnF	>60	>6	0–4	0.6–2.0	0.02–0.15	5.6–8.4	Low	Low	Low.
			4–72	0.6–2.0	0.02–0.08	5.6–8.4	Low	Low	Low.
Kiomatia: Ko	>60	>6	0–18	2.0–6.0	0.10–0.15	6.1–6.5	Low	Low	Low.
			18–56	6.0–20.0	0.05–0.10	6.1–7.8	Low	Low	Low.
Latanier: La	>60	>6	0–24	<0.06	0.18–0.20	6.6–8.4	High	High	Low.
			24–64	0.06–2.0	0.18–0.22	6.6–8.4	Low	High	Low.
Linker: LnB	20–40	>6	0–13	0.6–2.0	0.11–0.15	<4.5–5.5	Low	Low	High.
			13–16	0.6–2.0	0.11–0.17	<4.5–5.5	Low	Low	High.
			16–28	0.6–2.0	0.12–0.20	<4.5–5.5	Low	Low	High.
			28–34	0.6–2.0	0.12–0.20	<4.5–5.5	Low	Low	High.
			34						
Lula: LuB	40–60	>6	0–10	0.6–2.0	0.16–0.20	5.6–6.5	Low	Low	Moderate.
			10–18	0.6–2.0	0.16–0.20	5.6–6.5	Moderate	Moderate	Moderate.
			18–52	0.6–2.0	0.16–0.20	5.1–7.3	Moderate	Moderate	Moderate.
			52						
Mason: Ma	>60	>6	0–34	0.6–2.0	0.16–0.24	5.6–7.3	Low	Low	Moderate.
			34–52	0.2–0.6	0.15–0.20	5.6–6.5	Moderate	Moderate	Moderate.
			52–60	0.2–0.6	0.15–0.20	5.6–7.8	Moderate	Moderate	Moderate.
Moreland: Mo	>60	1–2	0–56	<0.06	0.18–0.20	6.1–8.4	High	High	Low.
Newtonia: NeB, NeC, NeC2.	>60	>6	0–14	0.6–2.0	0.16–0.24	5.6–6.5	Low	Moderate	Moderate.
			14–22	0.6–2.0	0.16–0.22	5.1–6.5	Moderate	Moderate	Moderate.
			22–60	0.6–2.0	0.18–0.22	5.1–6.0	High	Moderate	Moderate.
			60–80	0.6–2.0	0.12–0.22	5.1–5.5	High	High	Moderate.

TABLE 6.—*Estimated engineering properties*—Continued

Soil series and map symbols	Depth to—		Depth from surface	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
	Bedrock	Water table						Steel	Concrete
	Inches	*Feet*	*Inches*	*Inches per hour*	*Inches per inch of soil*	*pH*			
Okay: OaB, OaC	>60	>6	0–13	2.0–6.0	0.15–0.18	5.6–6.5	Low	Low	Moderate.
			13–40	0.6–2.0	0.12–0.18	5.1–6.5	Low	Moderate	Moderate.
			40–66	0.6–6.0	0.11–0.17	5.1–7.3	Low	Low	Moderate.
Okemah: OkA	>60	2–3	0–23	0.6–2.0	0.17–0.21	5.6–6.5	Low	High	Moderate.
			23–66	0.6–2.0	0.14–0.18	5.6–8.4	High	High	Moderate.
Osage:									
Os	>60	1–2	0–18	0.2–0.6	0.18–0.22	5.1–7.8	Moderate	High	Moderate.
			18–66	<0.06	0.14–0.18	5.1–7.8	High	High	Moderate.
Oy	>60	1–2	0–66	<0.06	0.14–0.18	5.1–7.8	High	High	Moderate.
Parsons: PaA	>60	0–1	0–12	0.6–2.0	0.17–0.21	5.1–6.5	Low	High	Moderate.
			12–80	<0.06	0.14–0.22	5.1–7.8	High	High	Moderate.
Radley: Ra, Rc	>60	>6	0–66	0.6–2.0	0.15–0.19	5.6–7.3	Moderate	Moderate	Low.
Rock outcrop.[3] Too variable to rate.									
Summit: SuB, SuC	>60	2–3	0–12	0.2–0.6	0.18–0.22	5.6–6.5	Moderate	High	Low.
			12–16	0.2–0.6	0.16–0.20	5.6–6.5	High	High	Low.
			16–40	0.6–0.2	0.14–0.18	6.1–8.4	High	High	Low.
			40–60	0.06–0.2	0.14–0.18	7.9–8.4	High	High	Low.
Taloka: TaA, TaB	>60	0–1	0–28	0.6–2.0	0.17–0.21	5.1–6.0	Low	High	Moderate.
			28–78	<0.06	0.14–0.22	5.1–8.4	High	High	Moderate.
Tullahassee: Tu	>60	0–1.5	0–16	2.0–6.0	0.12–0.16	5.6–6.5	Low	Moderate	Moderate.
			16–64	2.0–6.0	0.12–0.16	5.6–6.5	Low	Moderate	Moderate.

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or of one kind of soil and a land type. The other soil series in each case or the land type is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.
[2] Mapped only with Hector soils (HeF) in this county.
[3] Mapped only with Catoosa soils (CcD) in this county.

TABLE 7.—*Suitability of soils for sanitary facilities*

[Soil characteristics in this table are expressed in computer-adapted terms differing from those in the Soil Survey Manual. Refer to explanation of Key Phrases, page 65, for definition of "percs slowly" and other terms that describe soil characteristics]

Soil series and map symbols	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill
Barge: BaF	Severe: percs slowly; slope	Severe: slope	Severe: slope.
Bates: BbB, BbC, BbC2	Severe: depth to rock	Severe: depth to rock	Moderate: depth to rock.
Bonn, clayey subsoil variant: Bv.	Severe: percs slowly; wet	Slight	Severe: too clayey, wet.
Catoosa: CcD [1]	Severe: depth to rock	Severe: depth to rock; slope	Severe: depth to rock.
Choska: Cd	Moderate: floods	Severe: seepage	Severe: floods.
Choteau: ChB	Severe: percs slowly; wet	Slight	Moderate: too clayey; wet.
Coweta:			
CkC [1]	Severe: depth to rock	Severe: depth to rock	Severe: depth to rock.
CsF	Severe: depth to rock; large stones; slope.	Severe: depth to rock; large stones; slope.	Severe: depth to rock.
Dennis:			
DnB, DnC, DnC2	Severe: percs slowly; wet	Slight where slope is 1 to 3 percent. Moderate where slope is 3 to 5 percent. Severe where slope is more than 5 percent.	Severe: too clayey.
DxE [1]	Severe: percs slowly; wet; slope.	Severe: slope	Severe: too clayey.
Enders [2]	Severe: percs slowly	Severe: slope	Severe: too clayey; depth to rock.

TABLE 7.—*Suitability of soils for sanitary facilities*—Continued

Soil series and map symbols	Septic-tank absorption fields	Sewage lagoons	Sanitary landfill
Hector:			
HrC [1]	Severe: depth to rock	Severe: depth to rock; seepage.	Severe: depth to rock; seepage.
HeF,[1] HsF	Severe: depth to rock; slope	Severe: depth to rock; seepage; slope.	Severe: depth to rock; seepage; slope.
Kamie:			
KaE	Severe: slope	Severe: slope	Moderate: slope.
KfC, KfC2	Slight	Moderate: slope; seepage	Slight.
KmD3	Slight	Moderate: slope; seepage	Slight.
Kanima: KnF	Severe: slope	Severe: slope; seepage; small stones.	Severe: slope.
Kiomatia: Ko	Severe: floods	Severe: seepage; floods	Severe: floods.
Latanier: La	Severe: floods; percs slowly	Severe: floods	Severe: floods; too clayey; wet.
Linker: LnB	Severe: depth to rock	Severe: depth to rock	Severe: depth to rock.
Lula: LuB	Moderate: depth to rock	Moderate: depth to rock; seepage.	Severe: depth to rock.
Mason: Ma	Severe: percs slowly	Slight	Moderate: floods; too clayey.
Moreland: Mo	Severe: percs slowly; floods; wet.	Severe: floods	Severe: floods; too clayey.
Newtonia: NeB, NeC, NeC2	Slight	Moderate: seepage; slope	Moderate: too clayey.
Okay: OaB, OaC	Slight	Moderate: seepage; slope	Slight.
Okemah: OkA	Severe: percs slowly; wet	Slight	Moderate; too clayey.
Osage: Os, Oy	Severe: percs slowly; wet	Severe: floods	Severe: floods; wet; too clayey.
Parsons: PaA	Severe: percs slowly; wet	Slight	Severe: too clayey.
Radley:			
Ra	Severe: floods	Severe: floods	Severe: floods.
Rc	Severe: floods	Severe: floods	Severe: floods.
Rock outcrop [3]	Severe: depth to rock; rock outcrops.	Severe: depth to rock	Severe: depth to rock; rock outcrops.
Summit: SuB, SuC	Severe: percs slowly; wet	Moderate: depth to rock; slope.	Severe: depth to rock; too clayey.
Taloka: TaA, TaB	Severe: percs slowly; wet	Slight	Moderate: too clayey; wet.
Tullahassee: Tu	Severe: floods; wet	Severe: seepage; floods; wet.	Severe: floods; seepage.

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or of one kind of a soil and a land type. The other soil series or the land type is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.

[2] Mapped only with Hector soils (HeF) in this county.

[3] Mapped only with Catoosa soils (CcD) in this county.

TABLE 8.—*Relative limitation of soils for construction sites*

[Soil characteristics in this table are expressed in computer-adapted terms differing from those in the Soil Survey Manual. Refer to Explanation of Key Phrases, pages 65, for definition of "Shrink-swell" and other terms that describe soil characteristics. See text for definition of the terms "slight," "moderate," and "severe"]

Soil series and map symbols	Shallow excavations	Dwellings without basements	Local roads and streets
Barge: BaF	Severe: slope	Severe: slope	Severe: slope; low strength.
Bates: BbB, BbC, BbC2	Moderate: depth to rock	Moderate: shrink-swell	Moderate: low strength; shrink-swell.
Bonn, clayey subsoil variant: Bv.	Severe: wet; too clayey	Severe: wet; low strength; shrink-swell.	Severe: shrink-swell; low strength; wet.

TABLE 8.—*Relative limitation of soils for construction sites*—Continued

Soil series and map symbols	Shallow excavations	Dwellings without basements	Local roads and streets
Catoosa: CcD [1]	Severe: depth to rock	Moderate: depth to rock; low strength; shrink-swell.	Moderate: low strength.
Choska: Cd	Severe: floods	Severe: floods	Moderate: floods; low strength.
Choteau: ChB	Moderate: wet; too clayey	Severe: shrink-swell	Severe: shrink-swell.
Coweta:			
CkC [1]	Severe: depth to rock	Moderate: depth to rock; low strength.	Severe: depth to rock.
CsF	Severe: depth to rock; slope; large stones.	Severe: large stones; slope	Severe: depth to rock; slope; large stones.
Dennis:			
DnB, DnC, DnC2	Severe: too clayey	Severe: wet; shrink-swell	Severe: shrink-swell; wet.
DxE [1]	Severe: too clayey; slope	Severe: wet; shrink-swell	Severe: shrink-swell; wet.
Enders [2]	Severe: too clayey	Severe: low strength; shrink-swell.	Severe: shrink-swell; low strength.
Hector:			
HrC [1]	Severe: depth to rock	Severe: depth to rock	Severe: depth to rock.
HeF,[1] HsF	Severe: depth to rock; slope	Severe: depth to rock; slope	Severe: depth to rock; slope.
Kamie:			
KaE	Severe: slope	Severe: slope	Severe: slope.
KfC, KfC2	Slight	Moderate: low strength	Moderate: low strength.
KmD3	Slight	Moderate: low strength	Moderate: low strength.
Kanima: KnF	Severe: slope; small stones	Severe: slope	Severe: slope.
Kiomatia: Ko	Severe: floods	Severe: floods	Moderate: floods.
Latanier: La	Severe: floods; wet; too clayey.	Severe: floods; low strength; shrink-swell.	Severe: shrink-swell; low strength.
Linker: LnB	Severe: depth to rock	Moderate: depth to rock; low strength.	Moderate: low strength; depth to rock.
Lula: LuB	Moderate: depth to rock; too clayey.	Moderate: low strength; shrink-swell.	Moderate: shrink-swell; low strength.
Mason: Ma	Moderate: too clayey; floods	Severe: floods	Moderate: low strength; shrink-swell; floods.
Moreland: Mo	Severe: floods; wet; too clayey.	Severe: floods; low strength; shrink-swell; wet.	Severe: shrink-swell; low strength; floods.
Newtonia: NeB, NeC, NeC2	Moderate: too clayey	Severe: shrink-swell; low strength.	Severe: shrink-swell; low strength.
Okay: OaB, OaC	Slight	Moderate: low strength; shrink-swell.	Moderate: low strength; shrink-swell.
Okemah: OkA	Severe: wet; too clayey	Severe: shrink-swell; wet	Severe: shrink-swell; low strength.
Osage: Os, Oy	Severe: floods; wet	Severe: floods; wet	Severe: floods; wet.
Parsons: PaA	Severe: wet; too clayey	Severe: shrink-swell; low strength; wet.	Severe: shrink-swell; low strength.
Radley:			
Ra	Severe: floods	Severe: floods	Severe: low strength.
Rc	Severe: floods	Severe: floods	Severe: low strength; floods.
Rock outcrop [3]	Severe: depth to rock; rock outcrops.	Severe: depth to rock; rock outcrops.	Severe: depth to rock; rock outcrops.
Summit: SuB, SuC	Severe: too clayey; wet	Severe: low strength; shrink-swell; wet.	Severe: shrink-swell; low strength; wet.
Taloka: TaA, TaB	Severe: wet; too clayey	Severe: low strength; shrink-swell; wet.	Severe: shrink-swell; low strength.
Tullahassee: Tu	Severe: floods	Severe: floods; wet	Severe: floods.

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or one kind of soil and a land type. The other soils series or the land type is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC Linker.

[2] Mapped only with Hector soils (HeF) in this county.

[3] Mapped only with Catoosa soils (CcD) in this county.

TABLE 9.—*Suitability of soils for construction and waste disposal*

[Soil characteristics in this table are expressed in computer-adapted terms differing from those in the Soil Survey Manual. Refer to Explanation of Key Phrases, page 65, for definition of "low strength" and other terms that describe soil characteristics]

Soil series and map symbols	Road fill	Sand and gravel	Topsoil
Barge: BaF	Poor: slope; low strength	Unsuited: excess fines	Poor: slope.
Bates: BbB, BbC, BbC2	Fair: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
Bonn, clayey subsoil variant: Bv.	Poor: low strength; shrink-swell; wet.	Unsuited: excess fines	Poor; thin layer; wet; too clayey.
Catoosa: CcD [1]	Poor: low strength	Unsuited: excess fines	Fair: thin layer.
Choska: Cd	Fair: low strength	Unsuited: excess fines	Good.
Choteau: ChB	Poor: low strength; shrink-swell	Unsuited: excess fines	Good.
Coweta:			
CkC [1]	Poor: thin layer	Unsuited: excess fines	Fair: thin layer.
CsF	Poor: thin layer; slope	Unsuited: excess fines	Poor: slope; large stones.
Dennis:			
DnB, DnC, DnC2	Poor: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
DxE [1]	Poor: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
Enders [2]	Poor: low strength; shrink-swell	Unsuited: excess fines	Poor: thin layer; small stones.
Hector:			
HrC [1]	Poor: thin layer	Poor: thin layer	Poor: thin layer; small stones; area reclaim.
HeF,[1] HsF	Poor: thin layer; slope	Poor: thin layer; slope	Poor: thin layer; small stones; area reclaim; slope.
Kamie:			
KaE	Fair: low strength; slope	Unsuited: excess fines	Poor: too sandy.
KfC, KfC2	Poor: low strength	Unsuited: excess fines	Good.
KmD3	Poor: low strength	Unsuited: excess fines	Fair: too clayey.
Kanima: KnF	Poor: slope	Unsuited: excess fines Gravel: poor.	Poor: small stones.
Kiomatia: Ko	Good	Unsuited: excess fines	Good.
Latanier: La	Poor: low strength; shrink-swell	Unsuited: excess fines	Poor: too clayey.
Linker: LnB	Poor: low strength; thin layer	Unsuited: excess fines	Fair: thin layer.
Lula: LuB	Fair: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
Mason: Ma	Fair: low strength; shrink-swell	Unsuited: excess fines	Good.
Moreland: Mo	Fair: low strength; shrink-swell	Unsuited: excess fines	Poor: too clayey.
Newtonia: NeB, NeC, NeC2	Poor: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
Okay: OaB, OaC	Poor: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
Okemah: OkA	Fair: low strength; shrink-swell	Unsuited: excess fines	Fair: too clayey.
Osage: Os, Oy	Poor: low strength; shrink-swell	Unsuited: excess fines	Poor: too clayey; wet.
Parsons: PaA	Poor: low strength; shrink-swell	Unsuited: excess fines	Fair: thin layer.
Radley:			
Ra	Poor: low strength; shrink-swell	Unsuited: excess fines	Good.
Rc	Poor: low strength; shrink-swell	Unsuited: excess fines	Good.
Rock outcrop [3]	Poor: rock outcrops	Unsuited	Unsuited.
Summit: SuB, SuC	Poor: low strength; shrink-swell	Unsuited: excess fines	Poor: too clayey.
Taloka: TaA, TaB	Poor: low strength; shrink-swell	Unsuited: excess fines	Good.
Tullahassee: Tu	Fair: low strength; wet	Unsuited: excess fines	Good.

[1] Mapping units CcD, CkC, DxE, and HrC consist of more than one kind of soil or one kind of soil and a land type. The other soil series or the land type is as follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.

[2] Mapped only with Hector soils (HeF) in this county.

[3] Mapped only with Catoosa soils (CcD) in this county.

TABLE 10.—*Water management*

[Soil characteristics in this table are expressed in computer-adapted terms differing from those in the Soil Survey Manual. Refer to Explnation of Key Phrases, page 65, for definition of "seepage" and other terms that describe soil characteristics]

Soil series and map symbols	Limitations for—		Features affecting—		
	Pond reservoirs	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Barge: BaF	Moderate: seepage.	Slight	Percs slowly; slope.	Slope	Slope; percs slowly.
Bates: BbB, BbC, BbC2	Moderate: depth to rock.	Moderate: unstable fill; compressible; piping.	Depth to rock	Slope	Depth to rock; piping.
Bonn, clayey subsoil variant: Bv	Slight	Moderate: unstable fill; compressible.	Percs slowly; wet; excess salt.	Excess salt; slow intake; wet.	Percs slowly; wet.
Catoosa: CcD[1]	Severe: depth to rock.	Moderate: thin layer; unstable fill; compressible; piping.	Depth to rock	Rooting depth	Depth to rock; rooting depth; piping.
Choska: Cd	Severe: seepage.	Moderate: unstable fill; seepage; compressible; piping.	Floods	Floods: seepage	Floods: piping.
Choteau: ChB	Slight	Moderate: unstable fill; piping.	Percs slowly; wet	Slow intake	Percs slowly; wet; piping.
Coweta:					
CkC[1]	Severe: depth to rock.	Severe: depth to rock	Depth to rock	Rooting depth	Rooting depth; depth to rock.
CsF	Severe: depth to rock; slope.	Severe: depth to rock	Depth to rock; slope.	Rooting depth; slope.	Rooting depth; depth to rock; slope.
Dennis:					
DnB, DnC, DnC2	Slight	Moderate: unstable fill; piping; compressible.	Percs slowly; wet	Slow intake	Percs slowly; wet; piping.
DxE[1]	Slight	Moderate: unstable fill; piping; compressible.	Percs slowly; slope.	Slow intake; slope.	Percs slowly; wet; slope.
Enders[2]	Slight	Severe: compressible; unstable fill; low strength.	Percs slowly	Slow intake; slope.	Slope; percs slowly.
Hector:					
HrC[1]	Severe: depth to rock; seepage.	Severe: thin layer	Depth to rock	Droughty: seepage.	Depth to rock.
HeF,[1] HsF	Severe: depth to rock; percs rapidly.	Severe: thin layer	Slope; depth to rock.	Slope; seepage	Slope; depth to rock.
Kamie:					
KaE	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Slope	Slope	Slope; piping.
KfC, KfC2	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Not wet	Seepage	Piping.
KmD3	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Not wet	Seepage	Piping.
Kanima: KnF	Severe: seepage	Moderate: unstable fill; seepage; piping.	Slope	Seepage; slope	Slope; piping.
Kiomatia: Ko	Severe: seepage	Severe: unstable fill; piping.	Floods	Seepage; fast intake; floods.	Floods; piping.
Latanier: La	Moderate: seepage.	Moderate: unstable fill; compressible.	Floods: percs slowly.	Slow intake; floods.	Percs slowly; floods.
Linker: LnB	Severe: depth to rock.	Moderate: thin layer; unstable fill; compressible; piping.	Depth to rock	Rooting depth; droughty.	Depth to rock; piping.
Lula: LuB	Moderate: thin layer; seepage.	Moderate: thin layer; piping.	Depth to rock	Slope; seepage	Depth to rock; piping.

TABLE 10.—*Water management*—Continued

Soil series and map symbols	Limitations for—		Features affecting—		
	Pond reservoirs	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Mason: Ma	Moderate: seepage.	Moderate: piping; unstable fill; compressible.	Percs slowly	Favorable	Percs slowly; piping.
Moreland: Mo	Slight	Moderate: unstable fill; compressible.	Floods; percs slowly.	Slow intake; wet; floods.	Floods; percs slowly.
Newtonia: NeB, NeC, NeC2.	Moderate: seepage.	Moderate: unstable fill; compressible.	Not wet	Percs rapidly	Favorable.
Okay: OaB, OaC	Moderate: seepage.	Moderate: unstable fill; piping; compressible.	Not wet	Percs rapidly	Piping.
Okemah: OkA	Slight	Moderate: unstable fill.	Percs slowly; wet	Slow intake	Percs slowly; wet.
Osage: Os, Oy	Slight	Moderate: unstable fill; compressible.	Percs slowly; wet	Slow intake; floods.	Percs slowly; wet.
Parsons: PaA	Slight	Moderate: unstable fill; compressible.	Percs slowly; wet	Slow intake	Percs slowly; wet.
Radley:					
Ra	Moderate: seepage.	Moderate: unstable fill; low strength; compressible; piping.	Floods	Floods	Floods; piping.
Rc	Moderate: seepage.	Moderate: unstable fill; low strength; compressible; piping.	Floods	Floods	Floods; piping.
Rock outcrop [3]	Severe: depth to rock.	Severe: thin layer; rock outcrops.	Depth to rock	Rooting depth; droughty.	Depth to rock.
Summit: SuB, SuC	Moderate: depth to rock.	Severe: compressible; piping.	Percs slowly; wet	Slow intake	Percs slowly; wet; piping.
Taloka: TaA, TaB	Slight	Moderate: unstable fill; compressible.	Percs slowly; wet	Slow intake	Percs slowly; wet.
Tullahassee: Tu	Severe: Seepage	Moderate: unstable fill; piping.	Floods: wet	Wet: floods; seepage.	Floods: wet; piping.

[1] Mapping units CcD, CkC, DxE, ond HrC consist of more than one kind of soil or of one kind of soil and a land type. The other soil series or the land type is a follows: CcD, Rock outcrop; CkC, Bates; DxE, Radley; and HrC, Linker.

[2] Mapped only with Hector soils (HeF) in this county.

[3] Mapped only with Catoosa soils (CcD) in this county.

operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Properties that affect difficulty of layout and construction are slope, risk of soil erosion, and lateral seepage. Slope and lateral seepage also affect the flow of effluent. Large rocks and boulders increase the cost of construction of septic tank absorption fields.

Sewage lagoons are shallow ponds constructed to hold sewage at a depth of 24 to 60 inches for a long enough period for bacteria to decompose the solid waste. A lagoon has a nearly level floor and has sides, or embankments, of compacted soil material. The embankments are compacted to medium density, and the pond is protected against flooding. In determining the suitability of soils for the construction of sewage lagoons, properties are considered that affect the pond floor and the embankments. Those that affect the pond floor are permeability, content of organic matter, slope, and, if the floor needs to be leveled, depth to bedrock. The soil properties that affect embankments are the engineering properties of the embankment material, as interpreted from the Unified Soil Classification, and the amount of stones. Stones influence the ease of excavation and the ease of compaction of the embankment material.

Sanitary landfills are used to dispose of refuse. The waste is spread in thin layers, compacted, and covered with soil. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill use are ease of excavation, hazard of polluting ground water, and trafficability. Ratings apply only to a depth of about 72 inches, and therefore ratings of *slight* or *moderate* may not be valid if excavations are much deeper. For some soils, reliable predictions can be made to a depth of 120 to 180 inches, but in most instances geologic investigations are needed below a depth of about 72 inches.

Interpretations of soils for construction sites.—Table 8 contains information on the suitability of the soils for construction sites. In the following paragraphs are explanations of some of the interpretations given in that table.

Shallow excavations are those that require digging or trenching to a depth of less than 72 inches. Examples are excavations for pipelines, sewer lines, telephone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

The ratings for dwellings without basements in table 8 are for structures not more than three stories high and supported by foundation footings placed in undisturbed soil. These ratings also apply to commercial buildings that have these characteristics. The features that affect the rating of a soil for dwellings are those that relate to the capacity to support a load and to resist settlement under load and are those that relate to the ease of excavation. Soil properties that affect the capacity to support a load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect ease of excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

The ratings for *local roads and streets* in table 8 are for an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 72 inches deep.

Soil properties that most affect design and construction of roads and streets are the load-supporting capacity, the stability of the subgrade, and the workability and the quantity of available cut-and-fill material. The AASHO and Unified classifications and the shrink-swell potential indicate the traffic-supporting capacity of a soil. Wetness and flooding affect the stability of soils. Slope, depth over hard rock, content of stones and rocks, and wetness affect the ease of excavation of soils and the amount of cut and fill needed to reach an even grade.

Interpretations of soil as source material.—Table 9 contains information on the suitability of soils as a source of various materials. In the following paragraphs are explanations of the interpretations given in that table.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and they reflect the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance about where to look for probable sources of sand and gravel. A soil rated as a *good* or *fair* source generally has a layer at least 36 inches thick, the top of which is within a depth of 72 inches. The ratings do not take into account thickness of overburden, height of the water table, or other factors that affect mining of the materials. Also they do not indicate the quality of the deposit.

Topsoil is used to topdress an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material when preparing a seedbed, natural fertility of the material or its response to plants if fertilizer is applied, and absence of substances toxic to plants. The texture of a soil and the content of coarse fragments are characteristics that affect the suitability of a soil for use as topdressing. Also considered in the ratings is the damage that results in the area from which the topsoil is taken.

Interpretations of soils for water management.—Table 10 contains interpretations of the suitability of the soils for use in water management. In the following paragraphs are explanations of the interpretations given in that table.

Pond reservoirs are areas of water held behind a dam or embankment. Soils suitable for use as pond reservoirs have low seepage, which is related to their permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and that has favorable stability, shrink-swell potential, shear strength, and compactibility. The presence of stones or organic matter are unfavorable factors in the suitability of a soil for embankments, dikes, and levees.

An aquifer-fed excavated pond is a body of water created by excavating a pit or dugout into a groundwater aquifer. Excluded are ponds that are fed by runoff and embankment ponds that impound water to a depth of more than 36 inches. The suitability ratings are for properly designed, located, and constructed ponds that impound good-quality water. Properties affecting aquifer-fed ponds are a permanent water table and the permeability of the aquifer. Stoniness and rockiness are properties that interfere with excavation.

Drainage of crops and pasture is affected by such soil properties as permeability; texture; structure; depth over claypan, rock, or other layers that influence rate of water movement; depth of the water table; slope; stability of ditchbanks; susceptibility to stream overflow; salinity and alkalinity; and availability of outlets for drainage.

The *irrigation* of a soil is affected by such features as slope; susceptibility to flooding, water erosion, and soil blowing; texture; content of stones; accumulations of salts and alkalis; depth of root zone; rate of water intake at the surface; permeability of the soil below the surface layer; available water capacity; need for drainage; depth of the water table; and depth over bedrock.

Terraces and diversions are embankments or ridges constructed across a slope to intercept runoff and allow it to soak into the soil or flow slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth over bedrock of other unfavorable material; stoniness; permeability; and resistance to water erosion, soil slipping, and soil blowing. A suitable soil has outlets for runoff and is not difficult to vegetate.

Formation and Classification of the Soils

Discussed in this section are the major factors of soil formation as they relate to the soils of Wagoner County, the processes of soil formation, and the system of classifying soils into categories broader than the series.

Factors of Soil Formation

Soil is the product of five major factors of soil formation—parent material, climate, plants and animals (especially plants), relief, and time. If one of the factors —such as climate or vegetation—differs in one area from the same factor in another area, but the other four factors are the same, the soil formed in one area differs from that formed in the other area.

Parent material

Parent material is the unconsolidated material from which soil is formed. It influences the rate of soil formation; the chemical, physical, and mineralogical composition; and the color of the soil.

Soils on the uplands of Wagoner County formed in material weathered from sandstone, limestone, loamy and clayey sediment, and shale. Soils of the Bates, Hector, and Linker series are examples of soil that formed in material weathered from sandstone. Catoosa, Lula, and Summit soils formed in material weathered from limestone. Enders soils formed in material weathered from shale. Dennis, Okemah, and Parsons soils formed in loamy and clayey sediment.

Alluvium is extensive along the streams and rivers of the county. The kind of sediment deposited and the kinds of soil that formed in it depend largely on the source of the sediment and the velocity of the floodwaters. Kiomatia and Radley soils formed in the loamy or sandy sediment deposited near the stream when these streams overflowed. Moreland and Osage soils formed in clayey sediment deposited by slow-moving water at the outer edges of the flood plains.

Climate

Wagoner County has a warm, temperate climate. Precipitation is adequate for rapid leaching and plant growth. The climate is fairly uniform throughout the county, and differences among the soils cannot be attributed to differences in climate.

Plants and animals

Plants, burrowing animals, insects, and soil microorganisms have a direct influence on the formation of the soils. The native grasses and the trees in the county have had different effects on the losses and gains of organic matter and plant nutrients and on soil structure and porosity. Soils that formed under prairie vegetation, such as those of the Summit series, have a black surface layer and a moderately high content of organic matter. Soils that formed under trees, such as those of the Enders series, have a dark-brown surface layer and a moderate content of organic matter.

Relief

Relief has influenced the formation of the soils mainly through its effect on the movement of water, erosion, soil temperature, and the kind of plant cover. In Wagoner County relief is determined largely by the resistance of underlying formations to weathering and geological erosion.

Hector and Linker soils formed in similar sandstone parent material, but their development has been controlled to a large extent by relief. The shallow Hector soils are more sloping than the moderately deep Linker soils.

Time

Time as a factor in soil formation cannot be measured strictly in years. The length of time needed for the development of genetic horizons depends on the intensity and the interactions of soil-forming factors in promoting the losses, gains, transfers, or transformations of soil constituents that are necessary for forming soil horizons. Soils with no definite genetic horizons are young or immature. Mature or older soils have approached equilibrium with their environment and tend to have well-defined horizons.

The soils of Wagoner County range from young to old. Some of the old, mature soils are Parsons and Taloka soils on uplands. The Bates and Enders soils are younger, but they have well-expressed soil horizons. The Coweta and Hector soils are considered young soils. They have had sufficient time to develop well-expressed horizons, but because they are sloping, geological erosion has taken away soil material almost as fast as it formed. The Choska, Kiomatia, and Radley soils are on flood plains and have been developing for such a short time that they show little horizon development.

Processes of Soil Formation

Several processes were involved in the formation of the soils of Wagoner County. These processes are the accumulation of organic matter, the leaching of calcium carbonates and bases, the reduction and transfer of iron, and the formation and translocation of silicate clay minerals. The results of these processes are not evident to the same degree in all the soils of the county.

Most of the older soils in the county have three major horizons. Some of the properties in which the major horizons differ are color, texture, structure, consistence, reaction, organic-matter content, and thickness. Subdivisions of the major horizons are based on minor differences.

The A horizon is the surface layer. The A1 horizon is a division of the surface layer in which there is an accumulation of organic matter. The A2 horizon is a division that is lighter colored and strongly leached of bases. Many of the soils of this county, such as those of the Parsons series, have both A1 and A2 horizons.

The B horizon is the mineral horizon below the A horizon, generally called the subsoil. In the older soils of the county, such as those of the Parsons series, this is the horizon of maximum accumulation of silicate clay. The younger soils of the county, such as those of the Radley series, do not have a B horizon.

The C horizon is the weathered rock material. It has been little affected by soil-forming processes but may

have been modified by reductions of iron or accumulation of calcium carbonates.

The R layer is consolidated bedrock.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.[10]

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 11 the soil series of Wagoner County are placed in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol.*

SUBORDER. Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order.

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder.

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used to differentiate families (table 11).

SERIES. The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

General Facts About the County [11]

Additional information about the soil survey area is given in this section. It will be most useful to people not familiar with Wagoner County. It tells about the relief and drainage, settlement and development, natural resources, transportation and industry, farming, and climate.

Relief and Drainage

Most of Wagoner County is drained by the Arkansas River, Grand River, Verdigris River, and their tributaries. The major tributaries are Salt Creek, Adams Creek, Bull Creek, Flat Rock Creek, Joe Creek, and Concharty Creek.

Settlement and Development

Before 1800 the area now included in Wagoner County was the hunting grounds of Indian tribes, principally the Osage. Early traders reported an abundance of different species of wild game in the prairie areas, on the open and wooded hills, and along the streams.

[10] SIMONSON, ROY W., Soil Classification in the United States. Sci. 137: 1027–1034, 1962.
United States Department of Agriculture, Soil Classification, A Comprehensive System, 7th Approximation. 265 pp., illus., 1960. (Supplement issued March 1967.)

[11] DAN ROBERTSON, district conservationist, Soil Conservation Service, assisted in the preparation of this section.

TABLE 11.—*Classification of the soil series of Wagoner County*

Series	Family	Subgroup	Order
Barge	Fine-silty, mixed, nonacid, thermic	Hapludollic Arents	Entisols.
Bates	Fine-loamy, siliceous, mixed, thermic	Typic Argiudolls	Mollisols.
Bonn, clayey subsoil variant [1]	Fine, mixed, thermic	Typic Natraqualfs	Alfisols.
Catoosa	Fine-silty, mixed, thermic	Typic Argiudolls	Mollisols.
Choska	Coarse-silty, mixed, thermic	Fluventic Hapludolls	Mollisols.
Choteau	Fine, mixed, thermic	Aquic Paleudolls	Mollisols.
Coweta	Loamy, siliceous, thermic, shallow	Typic Hapludolls	Mollisols.
Dennis	Fine, mixed, thermic	Aquic Paleudolls	Mollisols.
Enders	Clayey, mixed, thermic	Typic Hapludults	Ultisols.
Hector	Loamy, siliceous, thermic	Lithic Dystrochrepts	Inceptisols.
Kamie	Fine-loamy, mixed, thermic	Typic Paleudalfs	Alfisols.
Kanima	Loamy skeletal, mixed, nonacid, thermic	Udalfic Arents	Entisols.
Kiomatia	Sandy, mixed, thermic	Typic Udifluvents	Entisols.
Latanier	Clayey over loamy, mixed, thermic	Vertic Hapludolls	Mollisols.
Linker [2]	Fine-loamy, siliceous, thermic	Typic Hapludults	Ultisols.
Lula	Fine-silty, mixed, thermic	Typic Argiudolls	Mollisols.
Mason	Fine-silty, mixed, thermic	Typic Argiudolls	Mollisols.
Moreland	Fine, mixed, thermic	Vertic Hapludolls	Mollisols.
Newtonia	Fine-silty, mixed, thermic	Typic Paleudolls	Mollisols.
Okay	Fine-loamy, mixed, thermic	Typic Argiudolls	Mollisols.
Okemah	Fine, mixed, thermic	Aquic Paleudolls	Mollisols.
Osage	Fine, montmorillonitic, thermic	Vertic Haplaquolls	Mollisols.
Parsons	Fine, mixed, thermic	Mollic Albaqualfs	Alfisols.
Radley	Fine-silty, mixed, thermic	Fluventic Hapludolls	Mollisols.
Summit	Fine, montmorillonitic, thermic	Vertic Argiudolls	Mollisols.
Taloka	Fine, mixed, thermic	Mollic Albaqualfs	Alfisols.
Tullahassee	Coarse-loamy, mixed, nonacid, thermic	Aquic Udifluvents	Entisols.

[1] The Bonn, clayey subsoil variant, in Wagoner County has thin silt coats on the ped surfaces in the upper part of the Bt horizon, but it lacks the glossic features of the Bonn series. The acreage is not sufficient to warrant a new series.

[2] These soils are taxadjuncts to the Linker series. They have reddish mottles in the upper part of the B horizon but are enough like the Linker series in morphology, composition, and behavior that a new series is not warranted.

They also reported an abundance of different species of fish in the streams in these areas.

The first major settlement in the area was Fort Gibson, which is on the east bank of the Grand River in what is now Muskogee County. It was established in 1824. Sam Houston was stationed at the fort from 1829 to 1833. Houston lived on the west side of Grand River in what is now Wagoner County. In 1836 the Cherokees were moved into this part of Oklahoma. Iron markers designating the western edge of the Cherokee Nation and the eastern boundary of the Creek Nation still stand in Wagoner County.

When Oklahoma was admitted to the Union in 1907, some lands were allotted to full-blooded Indians and were placed on a restricted list. Other lands were allotted to persons who were of Indian extraction but who were not full-blooded Indians. These lands could be used or sold without restrictions.

The Missouri-Kansas-Texas, the Missouri-Pacific, and the Midland Valley Railroads serve Wagoner County. Numerous early white settlements were along these railroads. The City of Wagoner, in early days, was served by three railroads. It became the largest of these settlements and was selected as the county seat. Wagoner was the first incorporated town in Indian Territory and was the first to establish public schools. The Tullahassee Mission was established in 1850 just east of Tullahassee. The church at this mission was the oldest Baptist Church reported in Oklahoma. The

present church is 2 miles southeast of the old mission site.

Three major rivers of this county have influenced the topography, soils, and development of the area. The Arkansas River flood plains form much of the southern boundary of Wagoner County. The Grand River forms all but about 6 miles of the east county line in the extreme northeast corner of the county. The Verdigris River dissects the county from north to south. It has been converted to a navigation canal in Wagoner County.

Trees along the Arkansas and Grand Rivers were cut in early days, and the land was converted to cropland. The trees of the Verdigris River flood plains have been cut at intervals since the day that Oklahoma first became a State. In recent years, beginning about 1945, concentrated efforts to remove all trees and brush from soils of the Verdigris River flood plains began. At present less than 10 percent of the areas of these soils are wooded. The rest has been converted to crops and tame pasture plants.

The prairie areas of the northwestern part of the county developed into large farms and ranches and were very prosperous until the depression in 1929. During the 1930s the farm economy was severely damaged, causing change of ownership of much of the lands. Since about 1950 several thousand acres of the northwest and western parts of Wagoner County have been converted to urban areas.

Fort Gibson Lake, east of Wagoner, was completed in 1951. The navigation canal of the Verdigris River began operations late in 1971.

The many miles of lake and navigation shoreline in the county, along with the wooded hills, have created a new industry—recreation. Many lakefront homes and vacation homes are being built in Wagoner County.

Natural Resources

The principal natural resources of the area include over 65,000 acres of productive flood plains along the Arkansas, Verdigris, and Grant Rivers; an abundance of water, native pasture plants, tame-pasture plants, timber, and gravel, and an abundance of game and fish. Oil, gas, and coal are also produced in Wagoner County.

The water supply for towns comes from lakes and rivers. Hydroelectric and flood-control reservoirs are used to produce electricity. Wells, springs, and ponds supply water for livestock. The water in the lakes and streams is of high quality.

The income from timber is much less than it was in the past. Most of the timber has been cut, and the trees that are left are of poor quality. This timber is now used mainly for the production of hand-tool handles, special furniture, and fireplace wood.

Native pasture provides some of the grazing for livestock and much of the hay fed in winter. Tame pasture provides most of the grazing in the county for livestock and some of the hay. Considerable alfalfa is grown on the flood plains of the county. Part of the alfalfa is processed by dehydration. Gravel and sand deposits are abundant.

Wildlife and fish are abundant in the area. Big-game animals have been restocked on the waterfowl refuge southeast of Wagoner. During short periods the reserve is open to deer hunting. Quail, dove, and duck, as well as other game, are hunted in season. Fishing is a year-round sport on the streams and lakes. Commercial fishing docks are heated in winter.

Clear-running streams and lakes in the wooded areas provide scenic beauty. The redbud and dogwood trees bloom in spring, and the leaves of the hardwood trees turn brilliant colors in fall. These two seasons, along with midsummer, bring many visitors to the county.

Transportation and Industry

Federal and State highways form a network of paved roads in the county. U. S. Highway 69 extends north to south across the county. U. S. Highway 64 crosses the southwestern corner of the county. U. S. Highway 66 is in the extreme northwest corner of the county. The Muskogee turnpike enters the county near the northwest corner and leaves the county near the southeast corner. State Highways 51, 51b, 16, 33, and 67 cross the county mainly in an east-west direction.

In all areas graded and graveled roads provide access to the hard-surfaced roads.

The county has navigation canal, railroad, bus, and freight services.

Grain elevators are at Wagoner, and a grain elevator is on the Verdigris Navigation Canal 5 miles west of Wagoner. Dairy and beef farmers market most of their milk products and beef in nearby large cities, mainly Tulsa and Muskogee.

A cotton gin is at Red Bird, and an alfalfa dehydrating mill is southwest of Porter. Two small sawmills are at Wagoner and Coweta, and a pipe fabricating and distribution plant is at Wagoner.

Farming

In Wagoner County the first settlers were Indians who observed grassy prairies, heavy stands of trees along the rivers and creeks, and a mixture of trees and grasses on the hills and ridges.

The flood plains as well as the uplands have contributed to crop diversification. For many years cotton was a major cash crop, and it is still important in Wagoner County. Small grain, alfalfa, cotton, soybeans, maize, mung beans, corn, peaches, apples, and spinach are the principal cultivated crops.

For many years the trend has been for the number of farms to decline and the size to increase. The proximity of Tulsa and Muskogee to Wagoner County is bringing in many people who are buying small tracts of land for country homes. Many of these people are raising livestock.

The percentage of farms operated by tenants in the county is small and continues to decline.

The increase of acreage in pasture has brought a large increase in the number of livestock.

The Choska bottom, located southwest of Porter, consists of about 13,000 acres of deep, fertile soils. It is the largest contiguous tract of soils on flood plains

uninterrupted by visible scars of erosion in Oklahoma. Yellow Water Creek, the main outlet for the water of the Choska bottom, was realined and enlarged in the late 1940's. Approximately ½ million cubic yards of earth was excavated from 14¼ miles of main channel and laterals. All work, except engineering assistance, was paid for by local people. The Soil Conservation Service provided engineering assistance. The 6,800 acres directly benefited by the improvement has changed this area from one of poor farms to an area of valuable, highly productive cropland. The Choska Conservancy District is responsible for continued operation and maintenance.

Climate [12]

The climate of Wagoner County varies from humid in the eastern part of the county to moist and subhumid in the western part. The two climatic regimes differ primarily in their principal vegetation, since normal precipitation is in excess of that needed for normal plant growth and development in each climate. The principal vegetation in a humid climate is trees, and the principal vegetation in a subhumid climate is grass. Areas where the climate is subhumid are susceptible to droughtiness. Temperature and precipitation data are given in table 12. Probability data for the occurrence of specified temperatures in spring and in fall are given in table 13.

[12] By BILLY R. CURRY, climatologist for Oklahoma, National Weather Service, U. S. Department of Commerce.

In Wagoner County 71 percent of the normal annual precipitation comes during the growing season, and a large percentage of it stems from thunderstorms that frequently produce high-intensity rainfall. Thunderstorms occur an average of 54 days during a normal 215-day growing season. Normally 36 days during the crop season have rainfall of 0.10 inch or more, 27 days have rainfall of 0.25 inch or more, 19 days have rainfall of 0.50 inch or more, 9 days have rainfall of 1 inch or more, and more than 2 days have rainfall of more than 2 inches. Since 1941, the greatest 24-hour rainfall at Wagoner was 6.21 inches in May 1950. It is estimated a 24-hour rainfall of 6.50 inches will occur an average of once every 10 years and a rainfall of 7.50 inches will occur once every 25 years. A 1-hour rainfall of 2.90 inches, it is estimated, will occur once every 10 years, and a 1-hour rainfall of 3.30 inches, once every 25 years.

The normal seasonal snowfall in Wagoner County is nearly 8 inches. Four days in an average year have snowfall of 1 inch or more and about 6 days have a snow cover of 1 inch or more. Since 1936, the greatest seasonal snowfall at Wagoner was 20.5 inches in 1969–70.

Temperatures of 90°F or higher are experienced frequently from June through September but have occurred from March through October. Temperatures of 100° or higher are experienced about 11 days each year, mostly in July and August. The highest temperature on record at Wagoner is 117° in August 1936.

Winters have frequent mild weather mixed with an occasional spell of cold weather. Minimum temperatures of 32°F or less occur on 84 days of a normal year, and on 6 days in a normal year, freezing temperatures

TABLE 12.—*Temperature and precipitation*

[All data from Wagoner; period of record 1941–70]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average monthly total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January	49	27	71	5	2.0	0.3	4.5	3	1
February	54	31	74	13	2.3	.4	4.6	1	2
March	62	38	82	17	3.1	1.0	6.5	1	3
April	74	50	88	31	5.0	1.4	9.5		
May	81	58	91	42	5.9	1.9	12.3		
June	89	67	98	53	5.0	1.5	8.5		
July	95	70	103	60	3.5	.1	9.9		
August	95	69	104	57	3.1	1.4	6.1		
September	87	61	99	44	3.9	.6	9.5		
October	77	50	90	31	3.4	.1	7.5		
November	62	38	80	19	2.5	.2	5.3		
December	52	30	71	10	2.2	.5	4.0	1	2
Year	73	49	[1] 105	[2] 2	41.9	26.8	52.4	6	2

[1] Average annual highest maximum.

[2] Average annual lowest minimum.

TABLE 13.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data from Muskogee, Muskogee County; period of record 1921–68]

Probability	Dates for given probability and temperature				
	16° F	20° F	24° F	28° F	32° F
Spring:					
1 year in 10 later than	March 10	March 16	March 28	April 8	April 13
2 years in 10 later than	March 1	March 9	March 21	April 2	April 9
5 years in 10 later than	February 10	February 22	March 7	March 22	March 31
Fall:					
1 year in 10 earlier than	November 26	November 19	November 7	October 27	October 17
2 years in 10 earlier than	December 3	November 26	November 13	November 2	October 22
5 years in 10 earlier than	December 20	December 10	November 25	November 12	November 1

continue throughout the day. Only 20 times in the past 19 years have temperatures dropped to 0° or below at Wagoner. The lowest temperature of record at Wagoner is −23°F in February 1899.

Freeze data are not available for Wagoner but are estimated on the basis of data available for Muskogee. The average date of the last spring freeze is March 31, and the average date of the first fall freeze is November 1. Freezing temperatures have occurred as late as May 1 and as early as October 7.

The prevailing wind direction is southerly, although northerly winds occur about as often as southerly winds from November through March. The average monthly windspeed varies from 7 mi/h in July to 12 mi/h in March and April. Strong, gusty winds occur with thunderstorms and with low-pressure systems that migrate from west to east in winter and spring.

The average monthly 6 a.m. relative humidity is 75 to 85 percent throughout the year, and the average monthly 6 p.m. relative humidity is about 56 percent in winter and about 53 percent in summer. An average of 130 clear days, 100 partly cloudy days, and 135 cloudy days provide the Wagoner County area with about 62 percent of the year's total possible sunshine.

Wagoner County, like all of Oklahoma, is susceptible to severe storms. The storms occur more frequently during hot afternoons in spring, but they have occurred in every month of the year and at every hour of the day. At any one location within the county, hail occurs on 4 days of an average year, although not all of the hailstorms are so intense that they cause damage to crops and property.

Glossary

ABC soil. A soil that has a complete profile, including an A, B, and C horizon.

AC soil. A soil that has an A and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizons above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Decreaser. Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or come combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Increasers. Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; increasers commonly are shorter than decreasers, and some are less palatable to livestock.

Invaders. On range, plants that come in and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many;* size—*fine*, *medium*, and *coarse;* and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distince kind of climax vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill normally is a few inches in depth and width and is not large enough to be an obstacle to farm machinery.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sand loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Variant, soil. A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

Explanation of Key Phrases

Area reclaim. Borrow areas are difficult to reclaim, and revegetation and erosion control on these areas are extremely difficult.

Compressible. The soil is relatively soft and decreases excessively in volume when a load is applied.

Depth to rock. Bedrock is so near the surface that it affects specified use of the soil.

Excess fines. The soil contains too much silt and clay for use as gravel or sand in construction.

Favorable. Features of the soil are favorable for the intended use.

Large stones. Rock fragments 10 inches or more across affect the specified use.

Low strength. The soil has inadequate strength to support loads.

Percs slowly. Water moves through the soil slowly, affecting the specified use.

Piping. The soil is susceptible to the formation of tunnels or pipelike cavities by moving water.

Rooting depth. A layer that greatly restricts the downward rooting of plants occurs at a shallow depth.

Seepage. Water moves through the soil so quickly that it affects the specified use.

Shrink-swell. The soil expands on wetting and shrinks on drying, which may cause damage to roads, dams, building foundations, or other structures.

Small stones. Rock fragments that are less than 10 inches across may affect the specified use.

Thin layer. Suitable soil material is not thick enough for use as borrow material or topsoil.

Unstable fill. Banks of fill are likely to cave in or slough.

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GUIDE TO MAPPING UNITS

For a complete description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. An outline of the capability classification of soils is given on pages 31 and 32. Pasture and hayland suitability groups are described on pages 34 and 35. Tree suitability groups are described in the section beginning on page 38. Other information is given in tables as follows:

Acreage and extent, table 1, p. 5.
Predicted yields, table 2, p. 33.
Wildlife, table 3, p. 41.
Recreational development, table 4, p. 43.
Engineering uses of the soils, tables 5, 6, 7, 8, 9, and 10, pp. 46 to 56.

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hayland suitability group	Tree suitability group
			Symbol	Name	Page	Symbol	Number
BaF	Barge soils, 0 to 30 percent slopes	5	VIIe-1	----------	--	8A	7
BbB	Bates fine sandy loam, 1 to 3 percent slopes	6	IIe-1	Loamy Prairie	37	8A	5
BbC	Bates fine sandy loam, 3 to 5 percent slopes	7	IIIe-1	Loamy Prairie	37	8A	5
BbC2	Bates fine sandy loam, 3 to 5 percent slopes, eroded	7	IIIe-3	Loamy Priarie	37	8A	5
Bv	Bonn silt loam, clayey subsoil variant	8	IVs-1	Shallow Claypan	38	8D	10
CcD	Catoosa-Rock outcrop complex, 1 to 8 percent slopes	8	VIIs-1	----------	--	--	--
	Catoosa part	--	------	Loamy Prairie	37	8A	7
	Rock outcrop part	--	------	----------	--	--	--
Cd	Choska silt loam	9	I-1	Loamy Bottomland	36	2A	1
ChB	Choteau silt loam, 1 to 3 percent slopes	10	IIe-1	Loamy Prairie	37	8A	8
CkC	Coweta-Bates complex, 2 to 5 percent slopes	10	VIe-4	----------	--	--	6
	Coweta part	--	------	Shallow Prairie	38	14A	--
	Bates part	--	------	Loamy Prairie	37	8A	--
CsF	Coweta stony soils, 5 to 30 percent slopes	11	VIIs-1	Shallow Prairie	38	14A	6
DnB	Dennis silt loam, 1 to 3 percent slopes	12	IIe-1	Loamy Prairie	37	8A	8
DnC	Dennis silt loam, 3 to 5 percent slopes	12	IIIe-2	Loamy Prairie	37	8A	8
DnC2	Dennis silt loam, 2 to 5 percent slopes, eroded	12	IIIe-3	Loamy Prairie	37	8A	8

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hayland suitability group	Tree suitability group
			Symbol	Name	Page	Symbol	Number
DxE	Dennis-Radley complex, 0 to 15 percent slopes	12	VIe-1	----------	--	--	8
	Dennis part	--	------	Loamy Prairie	37	8A	--
	Radley part	--	------	Loamy Bottomland	36	2A	--
HeF	Hector-Enders complex, 5 to 30 percent slopes	13	VIIs-2	----------	--	--	6
	Hector part	--	------	Shallow Savannah	38	--	--
	Enders part	--	------	Sandy Savannah	37	--	--
HrC	Hector-Linker complex, 1 to 5 percent slopes	13	IVe-1	----------	--	--	6
	Hector part	--	------	Shallow Savannah	38	14A	--
	Linker part	--	------	Sandy Savannah	37	8B	--
HsF	Hector soils, 20 to 50 percent slopes	14	VIIs-2	Savannah Breaks	37	--	6
KaE	Kamie loamy fine sand, 5 to 20 percent slopes	14	VIe-2	Sandy Savannah	37	9A	5
KfC	Kamie fine sandy loam, 1 to 5 percent slopes	14	IIIe-1	Sandy Savannah	37	8A	5
KfC2	Kamie fine sandy loam, 2 to 5 percent slopes, eroded	15	IIIe-3	Sandy Savannah	37	8A	5
KmD3	Kamie soils, 2 to 8 percent slopes, severely eroded	15	VIe-3	Eroded Sandy Savannah	36	9A	5
KnF	Kanima soils, 3 to 50 percent slopes	16	VIIs-3	----------	--	--	9
Ko	Kiomatia fine sandy loam	17	IIIs-1	Sandy Bottomland	37	3A	3
La	Latanier clay	18	IIIw-2	Heavy Bottomland	36	1A	4
LnB	Linker fine sandy loam, 1 to 3 percent slopes	19	IIe-2	Sandy Savannah	37	8B	5
LuB	Lula silt loam, 1 to 3 percent slopes	20	IIe-1	Loamy Prairie	37	8A	7
Ma	Mason silt loam	20	I-1	Loamy Bottomland	36	2A	1
Mo	Moreland clay	21	IIIw-1	Heavy Bottomland	36	1A	4
NeB	Newtonia silt loam, 1 to 3 percent slopes	21	IIe-1	Loamy Prairie	37	8A	7
NeC	Newtonia silt loam, 3 to 5 percent slopes	21	IIIe-1	Loamy Prairie	37	8A	7
NeC2	Newtonia silt loam, 2 to 5 percent slopes, eroded	21	IIIe-1	Loamy Prairie	37	8A	7

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hayland suitability group	Tree suitability group
			Symbol	Name	Page	Symbol	Number
OaB	Okay loam, 1 to 3 percent slopes---	22	IIe-1	Loamy Prairie	37	8A	5
OaC	Okay loam, 3 to 5 percent slopes---	22	IIIe-1	Loamy Prairie	37	8A	5
OkA	Okemah silt loam, 0 to 1 percent slopes----------	23	I-2	Loamy Prairie	37	8A	8
Os	Osage silty clay loam----------	24	IIw-2	Heavy Bottomland	36	2B	4
Oy	Osage clay----------	24	IIIw-1	Heavy Bottomland	36	1B	4
PaA	Parsons silt loam, 0 to 1 percent slopes----------	25	IIs-1	Claypan Prairie	36	8C	8
Ra	Radley silt loam----------	26	IIw-1	Loamy Bottomland	36	2A	1
Rc	Radley soils, channeled----------	27	Vw-1	Loamy Bottomland	36	2A	1
SuB	Summit silty clay loam, 1 to 3 percent slopes----------	27	IIe-1	Loamy Prairie	37	8A	8
SuC	Summit silty clay loam, 3 to 5 percent slopes----------	28	IIIe-2	Loamy Prairie	37	8A	8
TaA	Taloka silt loam, 0 to 1 percent slopes----------	28	IIs-1	Loamy Prairie	37	8C	8
TaB	Taloka silt loam, 1 to 3 percent slopes----------	29	IIe-1	Loamy Prairie	37	8C	8
Tu	Tullahassee fine sandy loam--------	29	Vw-2	Loamy Bottomland	36	2B	2

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

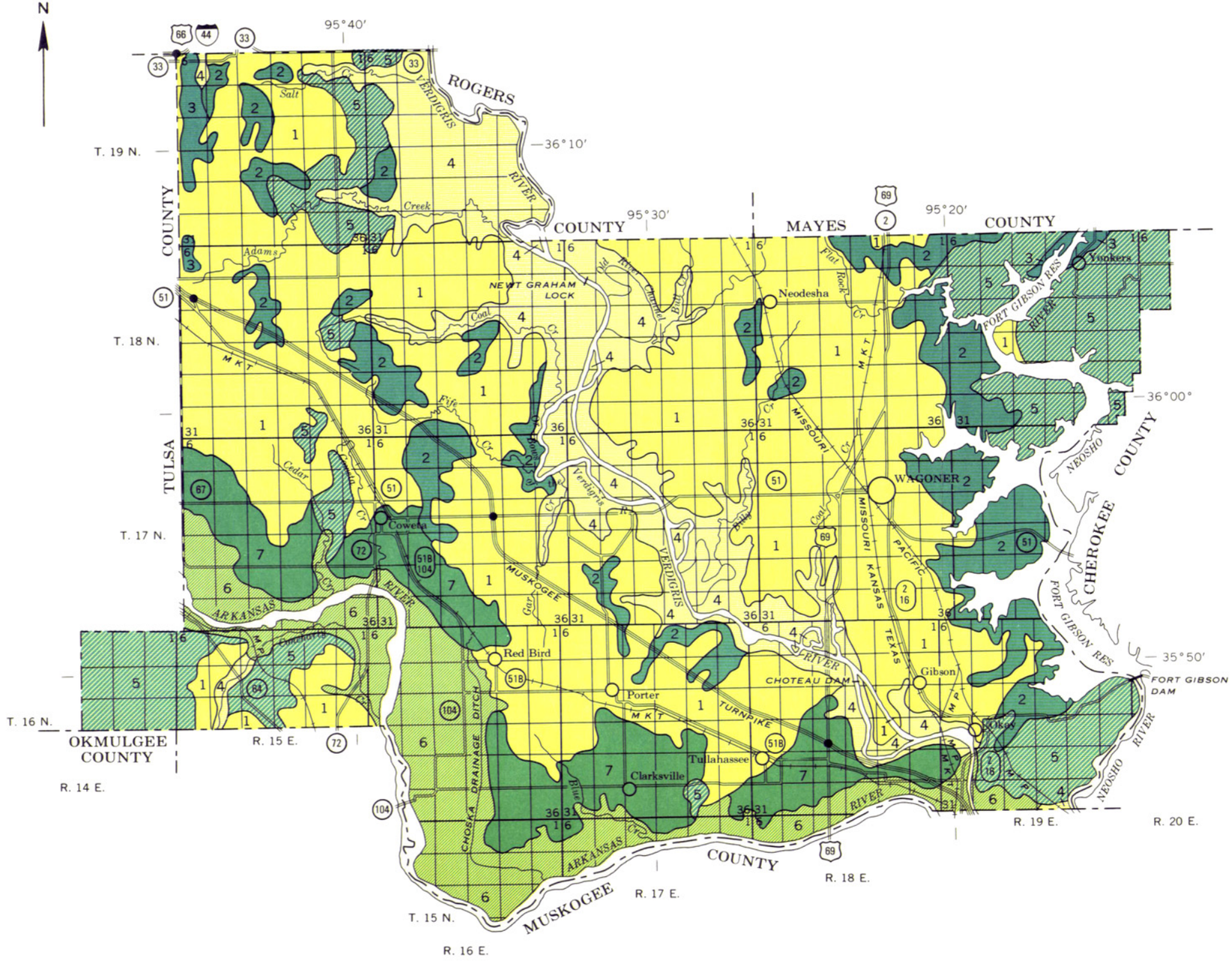
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

WAGONER COUNTY, OKLAHOMA

Scale 1:253,440

1 0 1 2 3 4 Miles



SOIL ASSOCIATIONS

1. Dennis-Taloka-Okemah association: Deep, nearly level to gently sloping, moderately well drained and somewhat poorly drained soils on uplands
2. Coweta-Bates association: Shallow and moderately deep, very gently sloping to steep, well drained and somewhat excessively drained soils on uplands
3. Summit-Catoosa association: Deep and moderately deep, very gently sloping to sloping, moderately well drained and well drained soils on uplands
4. Osage-Radley association: Deep, nearly level to gently sloping, moderately well drained and poorly drained soils on flood plains
5. Hector-Enders association: Shallow and deep, very gently sloping to very steep, well-drained soils on uplands
6. Choska-Mason-Tullahassee association: Deep, nearly level, well drained and somewhat poorly drained soils on low terraces and flood plains
7. Kamie-Newtonia-Okay association: Deep, very gently sloping to moderately steep, well-drained soils on uplands

Compiled 1974

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

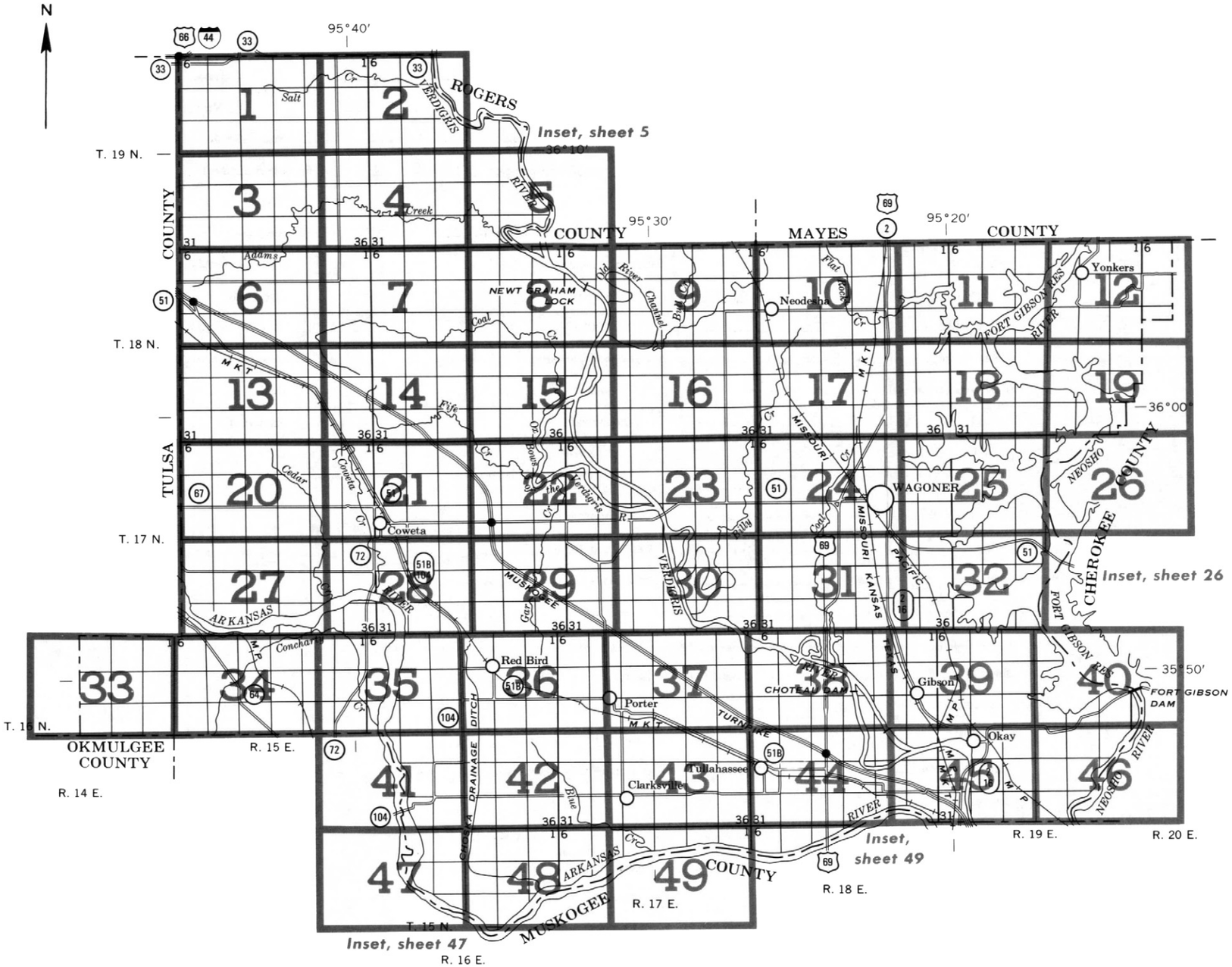
6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

WAGONER COUNTY, OKLAHOMA

Scale 1:253,440

1 0 1 2 3 4 Miles



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter shows class of slope. Most symbols without a slope letter are those of nearly level soils that have a considerable range of slope. A final number, 2 or 3, in the symbol shows that the soil is eroded or severely eroded.

SYMBOL	NAME
BaF	Barge soils, 0 to 30 percent slopes
BbB	Bates fine sandy loam, 1 to 3 percent slopes
BbC	Bates fine sandy loam, 3 to 5 percent slopes
BbC2	Bates fine sandy loam, 3 to 5 percent slopes, eroded
Bv	Bonn silt loam, clayey subsoil variant
CcD	Catoosa-Rock outcrop complex, 1 to 8 percent slopes
Cd	Choska silt loam
ChB	Choteau silt loam, 1 to 3 percent slopes
CkC	Coweta-Bates complex, 2 to 5 percent slopes
CsF	Coweta stony soils, 5 to 30 percent slopes
DnB	Dennis silt loam, 1 to 3 percent slopes
DnC	Dennis silt loam, 3 to 5 percent slopes
DnC2	Dennis silt loam, 2 to 5 percent slopes, eroded
DxE	Dennis-Radley complex, 0 to 15 percent slopes
HeF	Hector-Enders complex, 5 to 30 percent slopes
HrC	Hector-Linker complex, 1 to 5 percent slopes
HsF	Hector soils, 20 to 50 percent slopes
KaE	Kamie loamy fine sand, 5 to 20 percent slopes
KfC	Kamie fine sandy loam, 1 to 5 percent slopes
KfC2	Kamie fine sandy loam, 2 to 5 percent slopes, eroded
KmD3	Kamie soils, 2 to 8 percent slopes, severely eroded
KnF	Kanima soils, 3 to 50 percent slopes
Ko	Kiomatia fine sandy loam
La	Latanier clay
LnB	Linker fine sandy loam, 1 to 3 percent slopes
LuB	Lula silt loam, 1 to 3 percent slopes
Ma	Mason silt loam
Mo	Moreland clay
NeB	Newtonia silt loam, 1 to 3 percent slopes
NeC	Newtonia silt loam, 3 to 5 percent slopes
NeC2	Newtonia silt loam, 2 to 5 percent slopes, eroded
OaB	Okay loam, 1 to 3 percent slopes
OaC	Okay loam, 3 to 5 percent slopes
OkA	Okemah silt loam, 0 to 1 percent slopes
Os	Osage silty clay loam
Oy	Osage clay
PaA	Parsons silt loam, 0 to 1 percent slopes
Ra	Radley silt loam
Rc	Radley soils, channeled
SuB	Summit silty clay loam, 1 to 3 percent slopes
SuC	Summit silty clay loam, 3 to 5 percent slopes
TaA	Taloka silt loam, 0 to 1 percent slopes
TaB	Taloka silt loam, 1 to 3 percent slopes
Tu	Tullahassee fine sandy loam

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit (G.P.)

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Borrow pit (B.P.)

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 1

WAGONER COUNTY, OKLAHOMA NO. 1

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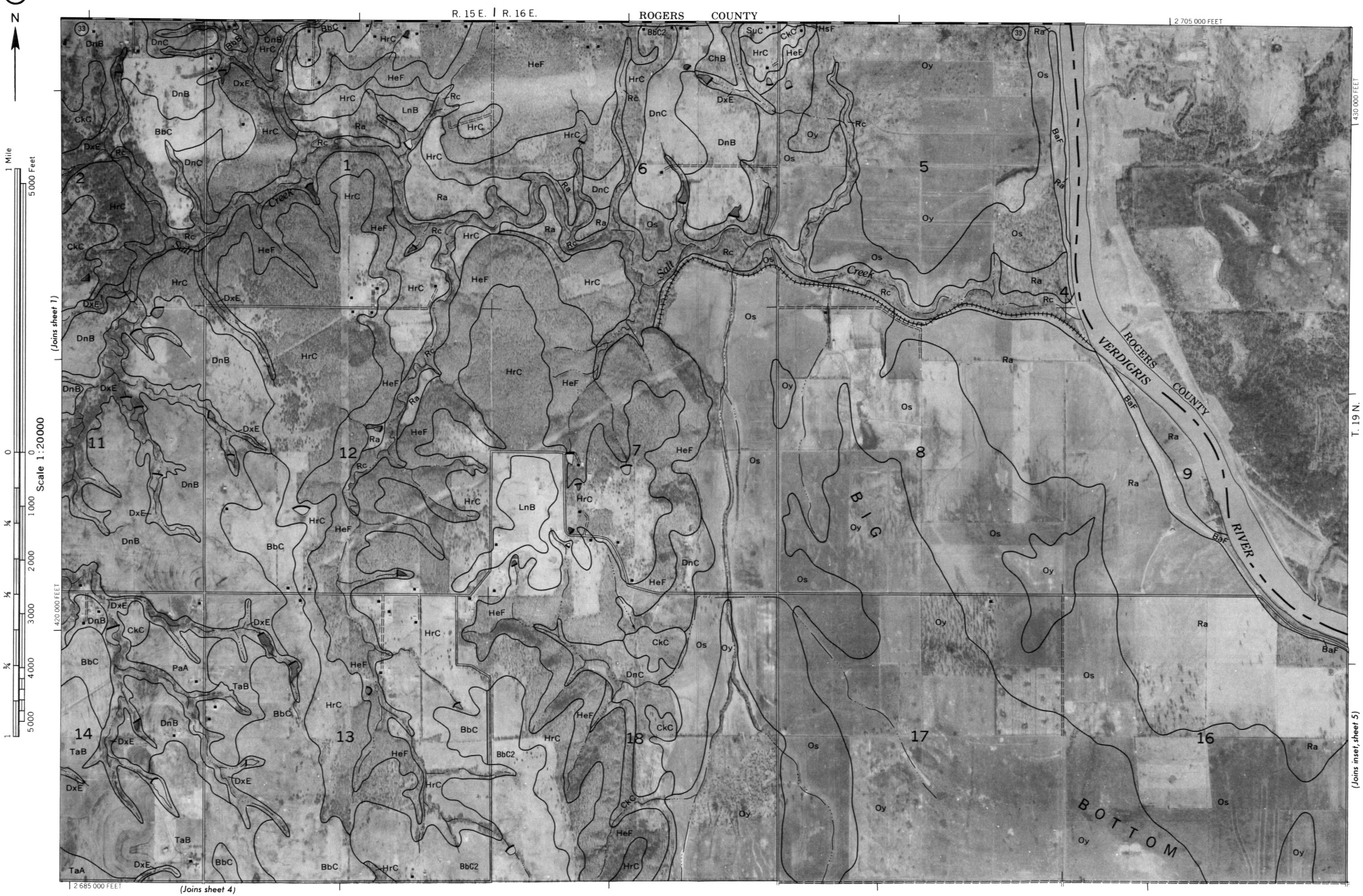

WAGONER COUNTY, OKLAHOMA NO. 2

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WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 3

WAGONER COUNTY, OKLAHOMA NO. 3

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2 665 000 FEET

R. 15 E.

(Joins sheet 1)

1 410 000 FEET

TULSA COUNTY T. 19 N.

SMITH CEMETERY

Adams Creek

(Joins sheet 4)

(Joins sheet 6)

2 685 000 FEET

1 400 000 FEET

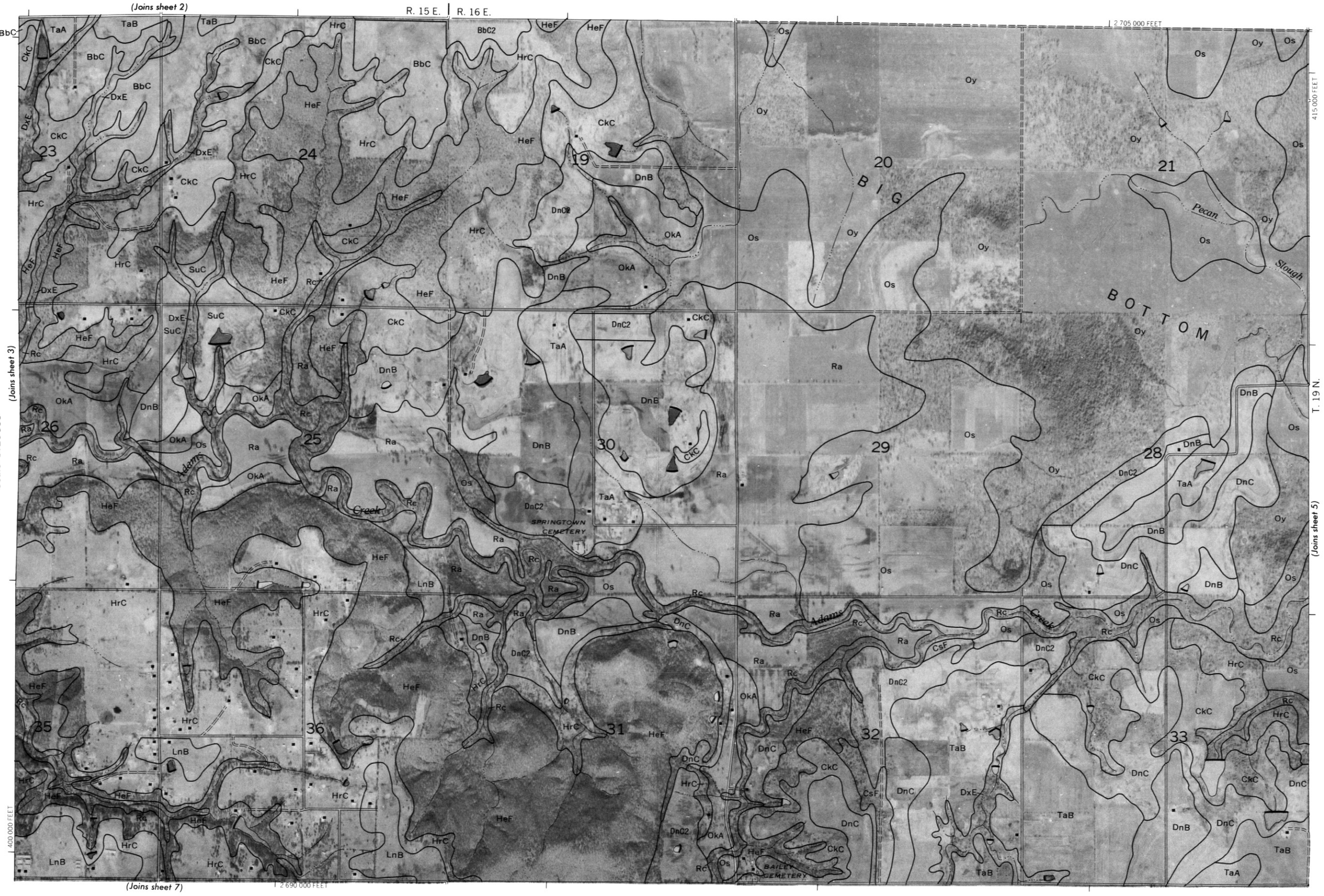
3

N

1 Mile

5 000 Feet

Scale 1:20000



WAGONER COUNTY, OKLAHOMA NO. 4

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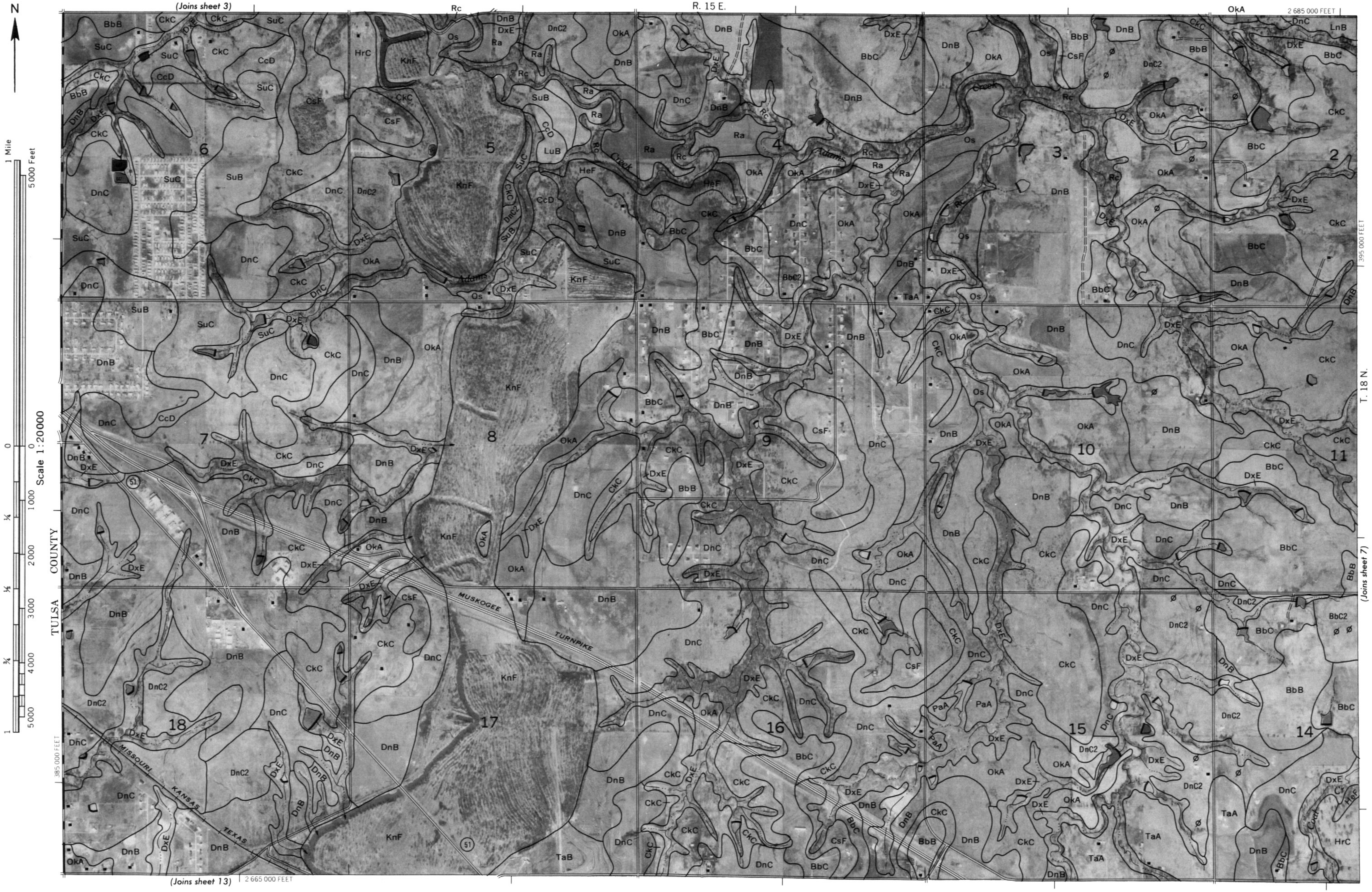
WAGONER COUNTY, OKLAHOMA NO. 5

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 6



WAGONER COUNTY, OKLAHOMA NO. 6

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Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA NO. 7

R. 15 E. | R. 16 E.

2 690 000 FEET

395 000 FEET

T. 18 N.

(Joins sheet 4)

(Joins sheet 6)

(Joins sheet 8)

(Joins sheet 14)

2 705 000 FEET

385 000 FEET

Sunnyside Church

Thomas Church

Coal Creek

Coal Creek

7

N

1 Mile

5000 Feet

Scale 1:20000

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 8

8

N

R. 16 E. | R. 17 E.

ROGERS COUNTY

2 730 000 FEET

400 000 FEET

T. 18 N.

(Joins sheet 5)

(Joins sheet 7)

(Joins sheet 9)

(Joins sheet 15)

2 710 000 FEET

385 000 FEET

1 Mile

5000 Feet

Scale 1:20000

GOODHOPE BOTTOM

VERDIGRIS RIVER

OX BOWS OF THE VERDIGRIS RIVER

NEWT GRAHAM LOCK (LOCK AND DAM NO 18)

Old River Channel

Coal Creek

Little Long Lake

Legas Lake

GUINN BOTTOM

water

DnB DnC DnC2 DxE CsF CkC HrC HeF BbB BbC2 BbC OkA Ra Rc Os Oy BaF PaA TaA ChB

1 2 3 5 6 7 8 10 11 12 13 14 15 17 18

WAGONER COUNTY, OKLAHOMA NO. 8

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 9

2 735 000 FEET

400 000 FEET

R. 17 E.

ROGERS COUNTY

T. 18 N.

(Joins sheet 8)

(Joins sheet 10)

(Joins sheet 16)

2 755 000 FEET

390 000 FEET

Willow Spring Church

Lone Star Church

WILLOW CEMETERY

MISSOURI

PACIFIC

Old River Channel

Bull Creek

GUINN BOTTOM

9

N

1 Mile

5 000 Feet

Scale 1:20000

10

N

MAYES COUNTY

R. 18 E.

2 780 000 FEET

400 000 FEET

T. 18 N.

1 Mile

5 000 Feet

Scale 1:20000

0 1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 9)

(Joins sheet 11)

(Joins sheet 17)

390 000 FEET

2 760 000 FEET

Neodesha

Flat Rock Creek

Flat Rock Creek

MISSOURI PACIFIC KANSAS TEXAS B.P.

BORROW PIT

PaA DxE DnB DnC CkC TaA TaB BbB BbC CsF OkA Ra

WAGONER COUNTY, OKLAHOMA NO. 10

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 11

11

N

2 785 000 FEET

R. 18 E. | R. 19 E.

MAYES COUNTY

400 000 FEET

T. 18 N.

FISHER CEMETERY

BORROW PIT

Tulsa YMCA Camp Takatoka

Waduhiola Recreational Area

Flat Rock Recreational Area

Rocky Point Recreational Area

Blue Bill Point

FLAT ROCK CREEK

FLAT ROCK BAY

FORT GIBSON RESERVOIR

NEOSHO RIVER

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 18)

2 800 000 FEET

1 Mile

5 000 Feet

Scale 1:20000

N

MAYES COUNTY

R. 19 E. | R. 20 E.

2 825 000 FEET

400 000 FEET

390 000 FEET

2 805 000 FEET

(Joins sheet 11)

(Joins sheet 19)

T. 18 N.

CHEROKEE COUNTY

FORT GIBSON RESERVOIR

NEOSHO RIVER

Big Hollow Public Use Area

Yonkers

B.P.

Big Hollow Creek

Dennis Creek

Jane Creek

1 Mile

5000 Feet

Scale 1:20000

0 0

¼ 1000

½ 2000

¾ 3000

1 4000

1¼ 5000

HsF HeF HrC LnB SuB SuC CcD DnB Ra Rc TaB OcD

WAGONER COUNTY, OKLAHOMA NO. 12

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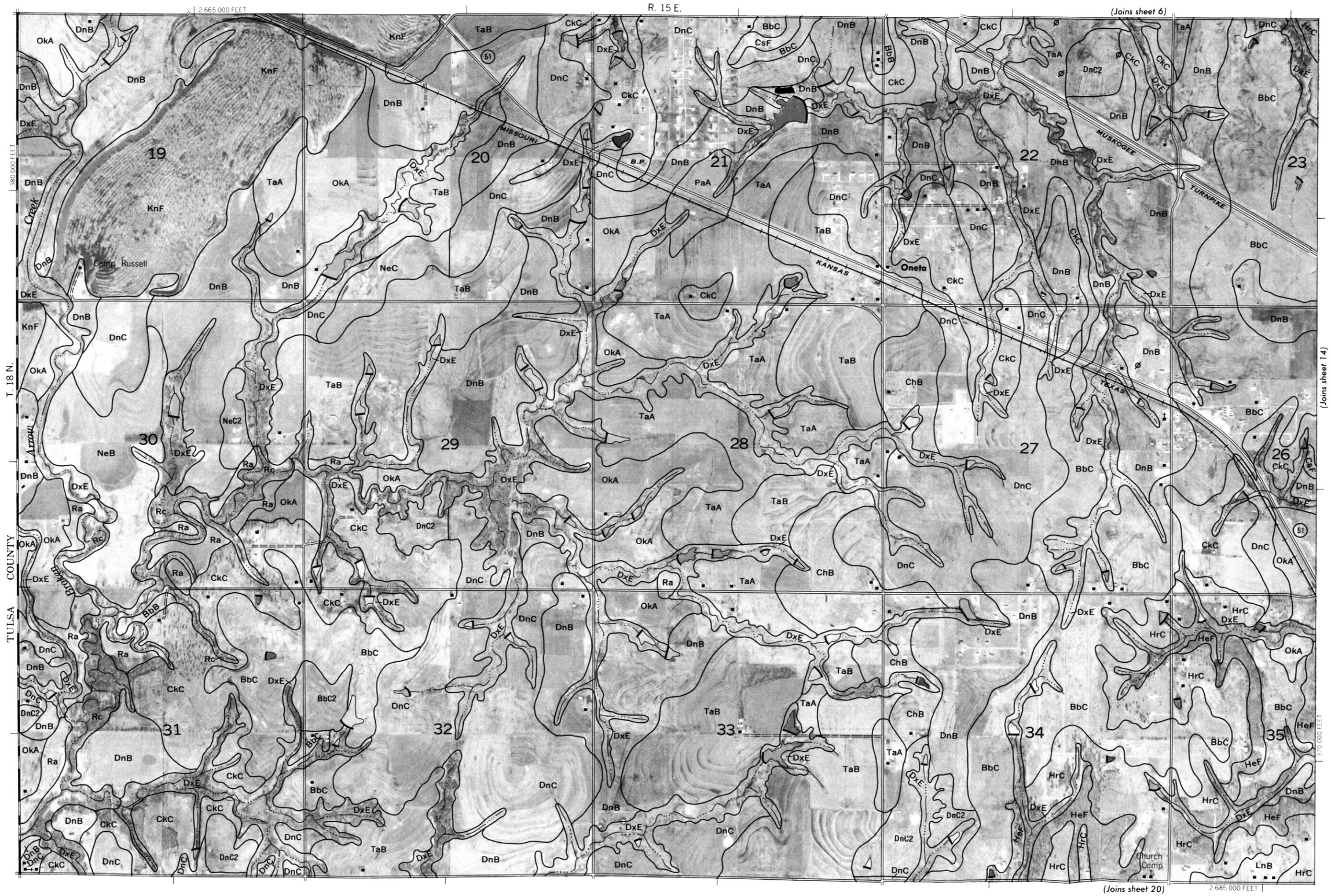
WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 13



WAGONER COUNTY, OKLAHOMA NO. 13

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WAGONER COUNTY, OKLAHOMA NO. 14

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WAGONER COUNTY, OKLAHOMA NO. 15

R. 16 E. | R. 17 E.

T. 18 N.

2 710 000 FEET

380 000 FEET

370 000 FEET

2 730 000 FEET

(Joins sheet 8)

(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 22)

N

Scale 1:20000

1 Mile

5000 Feet

Lone Star Church

Flag Lake

Coal Creek

RIVER

VERDIGRIS

OX BOWS OF THE VERDIGRIS RIVER

BORROW PIT

B.P.

Fire

N

(Joins sheet 9)

R. 17 E.

2 755 000 FEET

385 000 FEET

T. 18 N.

(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 23)

370 000 FEET

2 735 000 FEET

1 Mile

5 000 Feet

Scale 1 : 20000

0 1 000 2000 3000 4000 5000

Old River Channel Bull Creek

20 21 22 23 24 25 26 27 28 29 32 33 34 35 36

Ra Rc Os Oy ChB DnB DxE CkC TaA TaB DnC PaA Bv CsF OkA Osage Mound

WAGONER COUNTY, OKLAHOMA NO. 15

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies

Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA NO. 17

2 760 000 FEET

385 000 FEET

R. 18 E.

(Joins sheet 10)

T. 18 N.

(Joins sheet 16)

(Joins sheet 18)

(Joins sheet 24)

2 780 000 FEET

375 000 FEET

19 20 21 22 23 30 29 28 27 26 31 32 33 34 35

CkC DnB DnC DxE OkA PaA TaA TaB BbC BbB ChB CsF Bv

Lelicetta Billy

Missouri Pacific Railroad Kansas Texas Borrow Pit Creek water

17

N

1 Mile 5000 Feet

Scale 1:20000

18

N

(Joins sheet 11)

R. 18 E. | R. 19 E.

2 800 000 FEET

385 000 FEET

T. 18 N.

(Joins sheet 17)

(Joins sheet 19)

375 000 FEET

2 785 000 FEET

(Joins sheet 25)

Fort Gibson Reservoir

Rocky Point

Rocky Point Recreational Area

Big Bend

FORT GIBSON RESERVOIR

NEOSHO RIVER

Snug Harbor Public Use Area

Poindexter Club

Twin Oak Church

BORROW PIT

B.P.

23 24 19 20 21 26 25 30 29 28 35 36 31 32 33

DnB DxE CkC CsF HeF HrC TaB PaA OkA BbC DnC CcD HsF BbC2 LnB

1 Mile 5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

WAGONER COUNTY, OKLAHOMA NO. 18

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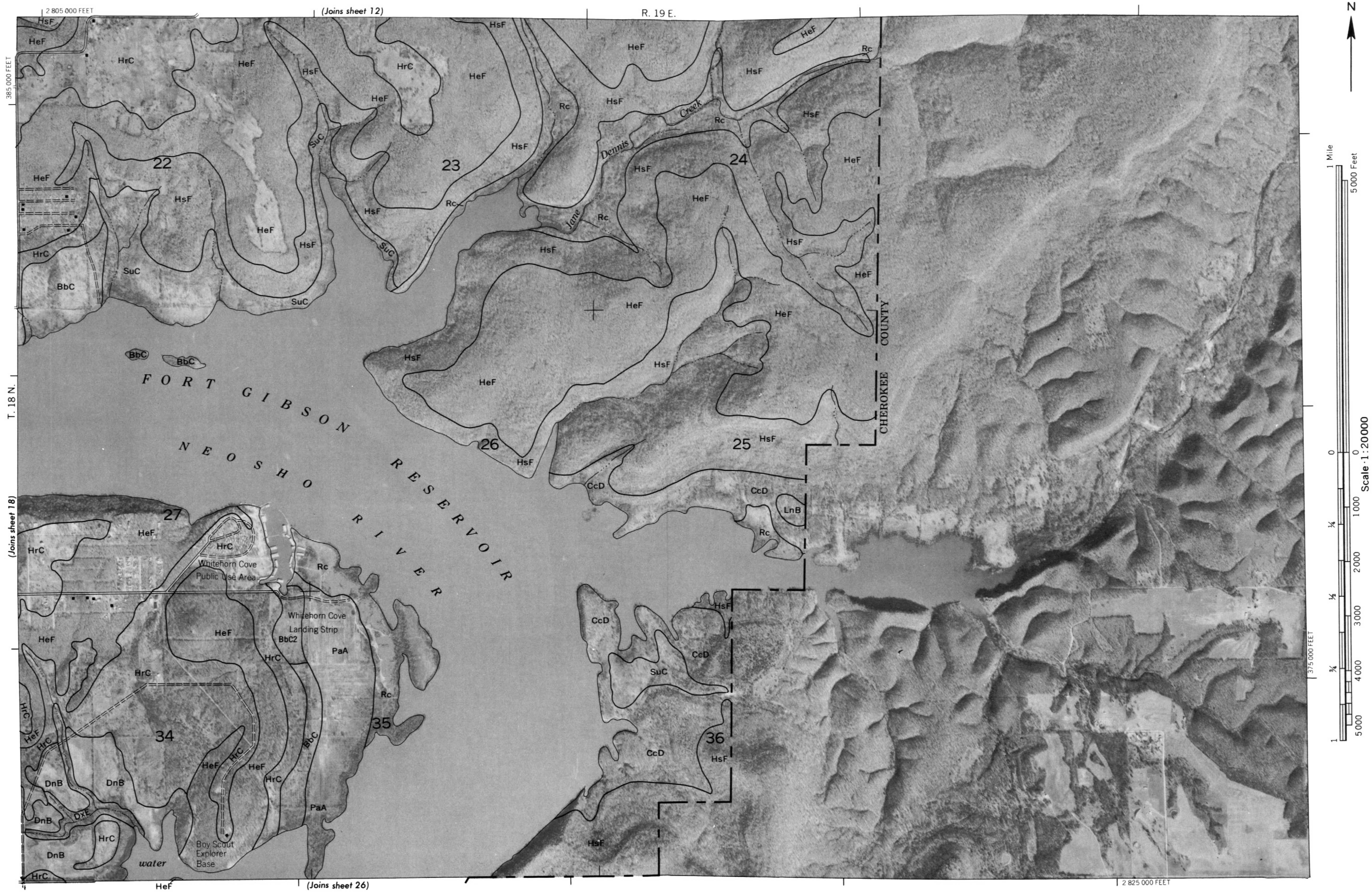
Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA NO. 19



20

N

(Joins sheet 13)

R. 15 E.

2 685 000 FEET

365 000 FEET

T. 17 N.

1 Mile

5000 Feet

0 0

Scale 1:20000

TULSA COUNTY

1000 ¼ 2000 ½ 3000 ¾ 4000 5000

355 000 FEET

2 665 000 FEET

(Joins sheet 27)

(Joins sheet 21)

Prairie Glade School

Jackson Grove Church

Wilson Chapel

Shahan Church

Cedar Creek Church

Cedar Creek

WAGONER COUNTY, OKLAHOMA NO. 20

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Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA NO. 21

R. 15 E. R. 16 E.

2 690 000 FEET

365 000 FEET

T. 17 N.

(Joins sheet 14)

(Joins sheet 20)

(Joins sheet 22)

(Joins sheet 28)

2 710 000 FEET

355 000 FEET

ODD FELLOW CEMETERY

MEMORIAL PARK CEMETERY

VERNON CEMETERY

COWETA

MISSOURI-KANSAS-TEXAS

MUSKOGEE TURNPIKE

Coweta Creek

Ra Creek

1 Mile

5000 Feet

Scale 1:20000

N

22

N

Scale 1:20000

1 Mile 5000 Feet

0 0 ¼ ½ ¾ 1

1000 2000 3000 4000 5000

(Joins sheet 15)

(Joins sheet 21)

(Joins sheet 29)

(Joins sheet 23)

R. 16 E. | R. 17 E.

T. 17 N.

2 730 000 FEET

365 000 FEET

355 000 FEET

2 715 000 FEET

OX BOWS OF THE VERDIGRIS RIVER

VERDIGRIS RIVER

Horseshoe Bend

Fite Creek

Mar Creek

Gar Creek

BORROW PIT

TURNPIKE

MUSKOGEE

B.P.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

CsF DnB DnC DnC2 DxE BbC CkC HrC HeF LnB Mar Ra Rc Os OkA TaA TaB BaF Oy ChB PaA

WAGONER COUNTY, OKLAHOMA NO. 22

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WAGONER COUNTY, OKLAHOMA NO. 23

N

R. 18 E.

T. 17 N.

2 780 000 FEET

370 000 FEET

355 000 FEET

2 760 000 FEET

(Joins sheet 17)

(Joins sheet 23)

(Joins sheet 25)

(Joins sheet 31)

Scale 1:20000

1 Mile

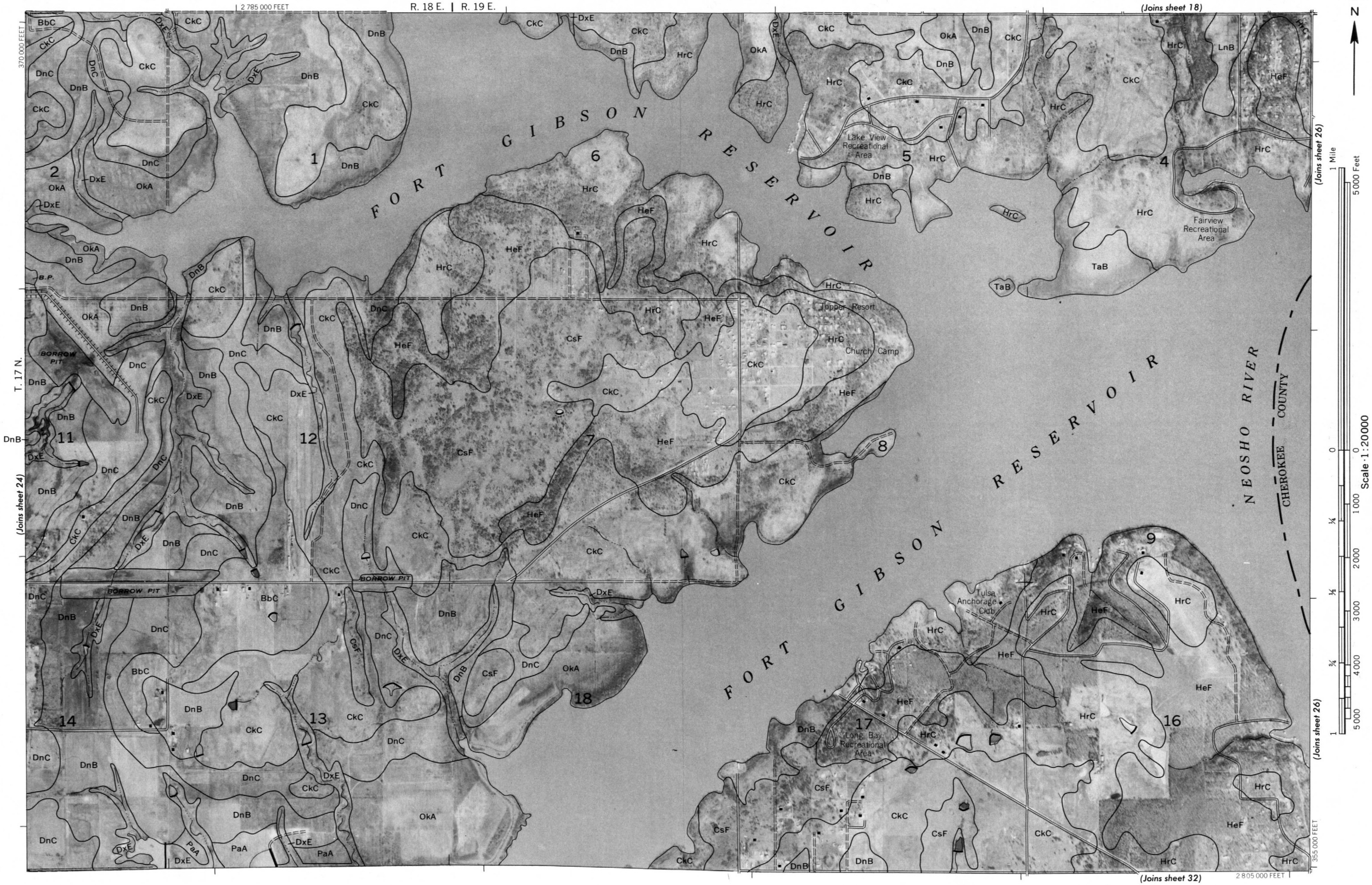
5000 Feet

0 0 ¼ ½ ¾ 1

1000 2000 3000 4000 5000

WAGONER COUNTY, OKLAHOMA NO. 24

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



WAGONER COUNTY, OKLAHOMA NO. 25

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

1 ¾ ½ ¼ 0 1 Mile

5000 4000 3000 2000 1000 0 5000 Feet

Scale 1:20000

N

355 000 FEET

(Joins sheet 25)

(Joins sheet 25)

(Joins inset)

(Joins sheet 19)

2 810 000 FEET

2 815 000 FEET

CHEROKEE COUNTY RESERVOIR

FORT GIBSON

NEOSHO RIVER

HrC

HeF

15

3

HrC

HeF

DrB

SuB

Tulakogee Camp

FORT GIBSON RESERVOIR

NEOSHO RIVER

CHEROKEE COUNTY

R. 19 E.

T. 17 N.

370 000 FEET

348 000 FEET

(Joins sheet 32)

2 806 000 FEET

(Joins lower left)

2 811 000 FEET

FORT GIBSON

NEOSHO

HrC

51

22

HeF

HrC

Recreational Area

Taylor Ferry

RESERVOIR

RIVER

CHEROKEE COUNTY

R. 19 E. INSET

T. 17 N.

353 000 FEET

WAGONER COUNTY, OKLAHOMA NO. 26

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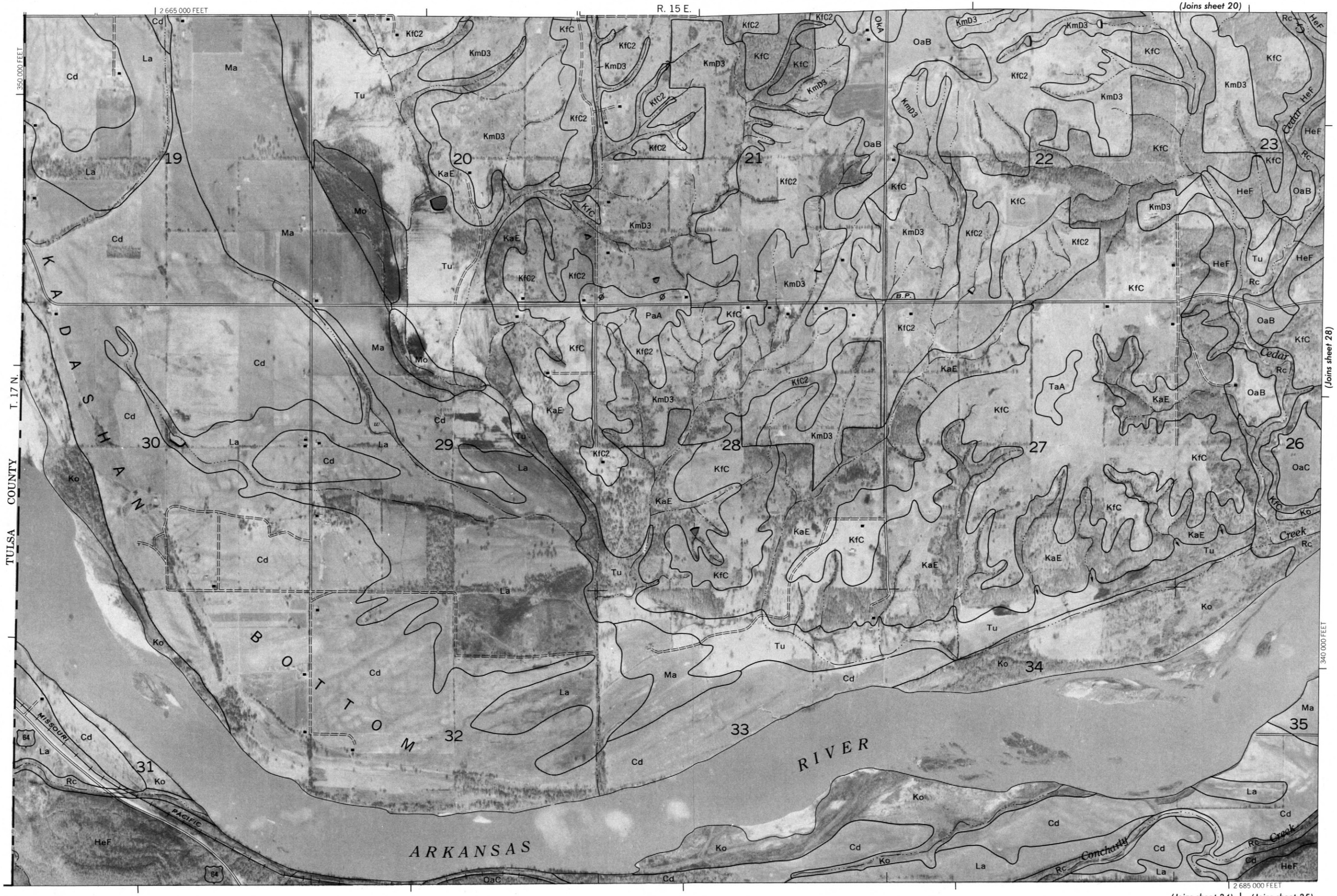

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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WAGONER COUNTY, OKLAHOMA NO. 27

28

N

R. 15 E. | R. 16 E.

(Joins sheet 21)

2 710 000 FEET

350 000 FEET

T. 17 N.

(Joins sheet 27)

340 000 FEET

2 690 000 FEET

(Joins sheet 29)

(Joins sheet 35) | (Joins sheet 36)

1 Mile

5000 Feet

Scale 1:20000

0 1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

ARKANSAS RIVER

Coweta Creek

Concharty Creek

MISSOURI KANSAS TEXAS

water

HeF HrC Rc DnC DxE DnB NeC KfC KfC2 Ra NeC2 CnB CkC CsF PaA DxF TaB DnC2 OkA OaB OaC Ko Cd Tu Ma La Mo

23 24 19 20 21 25 26 30 29 28 35 36 31 32 33

518 104 72

WAGONER COUNTY, OKLAHOMA NO. 28
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 29

29

N

2 715 000 FEET

R. 16 E. | R. 17 E.

(Joins sheet 22)

350 000 FEET

T. 17 N.

(Joins sheet 28)

(Joins sheet 30)

340 000 FEET

2 730 000 FEET

(Joins sheet 36) | (Joins sheet 37)

1 Mile

5000 Feet

Scale 1:20000

N

(Joins sheet 23)

R. 17 E.

2 755 000 FEET

T. 17 N.

350 000 FEET

(Joins sheet 29)

Scale 1:20000

1 Mile 5000 Feet

0 0 1/4 1000 2000 3000 4000 5000

340 000 FEET

2 735 000 FEET

(Joins sheet 31)

(Joins sheet 37) (Joins sheet 38)

OX BOWS OF THE VERDIGRIS RIVER

VERDIGRIS RIVER

Old River Channel

Old River Channel

Hilly Creek

Creek

Creek

Strandberry

20 21 22 23 24 25 26 27 28 29 32 33 34 35 36

PaA DxE TaB NeC NeB2 DnC2 OkA Os Oy Ra Rc BaF TaA ChB DnB CkC BbC CsF NeB HrC HsF

WAGONER COUNTY, OKLAHOMA NO. 30

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WAGONER COUNTY, OKLAHOMA NO. 31

R. 18 E.

2 760 000 FEET

350 000 FEET

T. 17 N.

(Joins sheet 24)

(Joins sheet 30)

(Joins sheet 32)

(Joins sheet 38)

(Joins sheet 39)

2 780 000 FEET

340 000 FEET

Choteau Reservoir

MISSOURI

KANSAS

TEXAS

PACIFIC

B.P.

Scale 1:20000

1 Mile

5000 Feet

N

R. 18 E. | R. 19 E.

(Joins sheet 25)

2 805 000 FEET

(Joins inset, sheet 26)

T. 17 N.

350 000 FEET

(Joins sheet 31)

340 000 FEET

2 785 000 FEET

(Joins sheet 39) | (Joins sheet 40)

FORT GIBSON RESERVOIR

NEOSHO RIVER

CHEROKEE COUNTY

Jackson Bay

MISSOURI PACIFIC

BORROW PIT

B.P.

23 24 19 20 21 26 25 30 29 28 35 36 31 32 33

DnC CkC DnB DxE CsF OkA TaB PaA TaA Rc BbC CcD HrC HeF Bv

N

Scale 1:20000

1 Mile 5000 Feet

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

WAGONER COUNTY, OKLAHOMA NO. 32

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 33

33

N

R. 14 E.

2 640 000 FEET

330 000 FEET

T. 16 N.

TULSA COUNTY

OKMULGEE COUNTY

2 660 000 FEET

320 000 FEET

(Joins sheet 34)

HeF HrC Rc LnB

1 2 3 10 11 12 13 14 15

1 Mile 5000 Feet

0 1 2 3 4 5000

0 ¼ ½ ¾ 1

Scale 1:20000

0 ¼ ½ ¾ 1 1000 2000 3000 4000 5000

WAGONER COUNTY, OKLAHOMA NO. 33

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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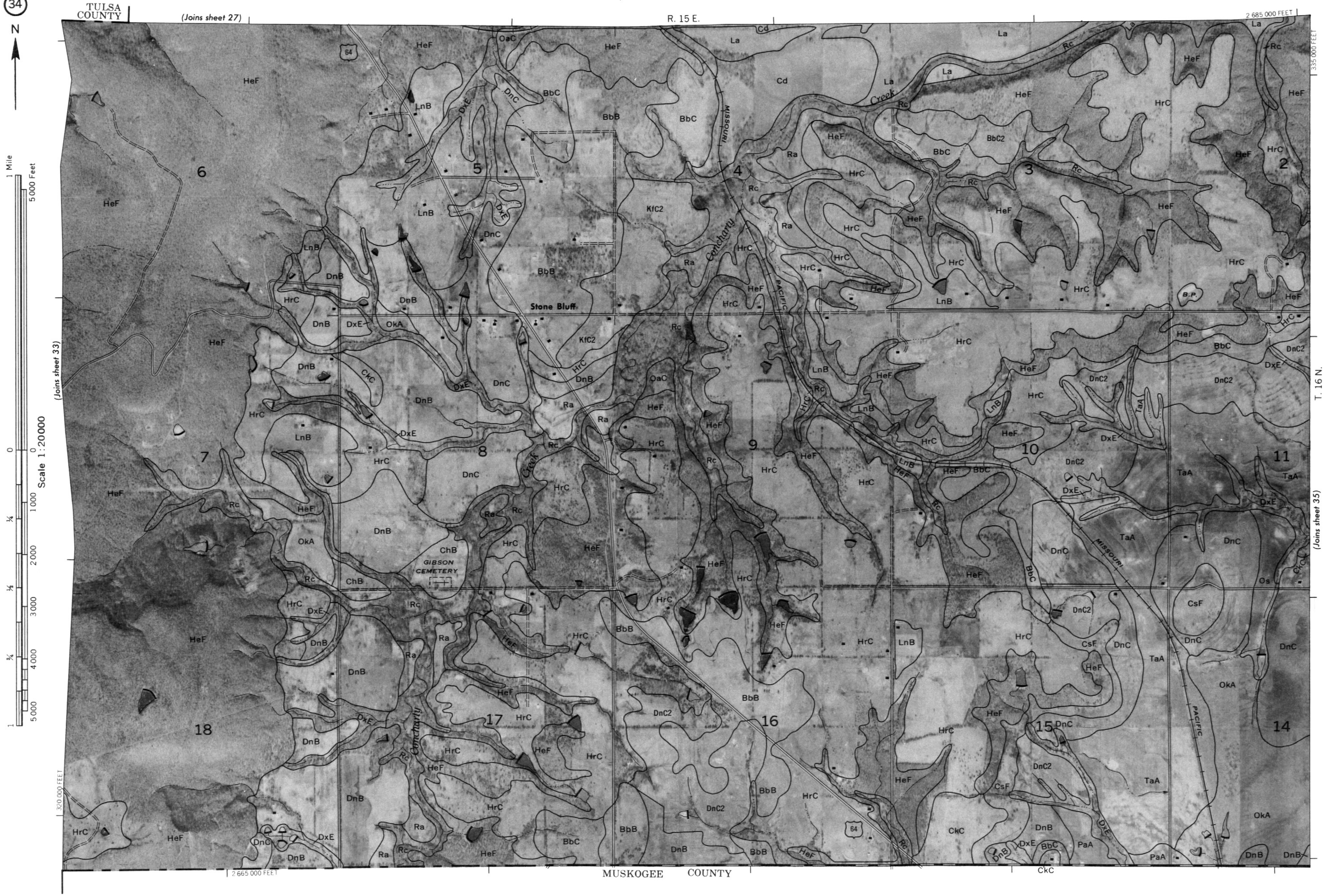

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 34

WAGONER COUNTY, OKLAHOMA NO. 35

(Joins sheet 27) (Joins sheet 28) (Joins sheet 34) (Joins sheet 36) (Joins sheet 41)

2 690 000 FEET 335 000 FEET 325 000 FEET 2 705 000 FEET

R. 15 E. R. 16 E. NeC

T. 16 N.

RIVER ARKANSAS Canadian Creek

Choska Landing Strip Stones Corner

MUSKOGEE COUNTY

35 N

1 Mile 5,000 Feet

Scale 1:20000

(Joins sheet 28) | (Joins sheet 29)

R. 16 E. | R. 17 E.

2 730 000 FEET

335 000 FEET

T. 16 N.

(Joins sheet 35)

(Joins sheet 37)

325 000 FEET

2 710 000 FEET

(Joins sheet 42)

Scale 1:20000

1 Mile | 5000 Feet | 1000 | 2000 | 3000 | 4000 | 5000

Red Bird | Stones Corner | Landing Strip

MISSOURI | KANSAS | TEXAS

Creek | Ditch | Drainage

WAGONER COUNTY, OKLAHOMA NO. 36

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(Joins sheet 29) | (Joins sheet 30)

37

N

R. 17 E.

2 735 000 FEET

335 000 FEET

T. 16 N.

(Joins sheet 36)

(Joins sheet 38)

(Joins sheet 43)

2 755 000 FEET

325 000 FEET

VERDIGRIS RIVER

OX BOWS OF THE VERDIGRIS R

MUSKOGEE TURNPIKE

MISSOURI KANSAS TEXAS

Strawberry Creek

GREENWOOD CEMETERY

LINCOLN CEMETERY

BORROW PIT

Porter

B.P.

1 Mile

5000 Feet

Scale 1:20000

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 37

38

N

(Joins sheet 30) (Joins sheet 31) R. 18 E. 2 775 000 FEET

(Joins sheet 37)

(Joins sheet 39)

T. 16 N.

335 000 FEET

325 000 FEET

(Joins sheet 44) 2 760 000 FEET

1 Mile 5 000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

VERDIGRIS RIVER

OX BOWS OF THE VERDIGRIS R

OX BOWS OF THE VERDIGRIS RIVER

Choteau Reservoir

Vanns Lakes

BORROW PIT

CHOTEAU DAM NO 17

CHOTEAU LOCK NO 17

MUSKOGEE TURNPIKE

Big Creek

Oy BaF Os Rc Ra TaB OaC DnC DnC2 DxE TaA PaA NeB DnB HeF NeC ChB OkA CsF BbB CkC Tu

5 6 4 3 2 1 7 8 9 10 11 12 18 17 16 15 14 13

WAGONER COUNTY, OKLAHOMA NO. 38

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA NO. 39

(Joins sheet 31) (Joins sheet 32)

2 780 000 FEET

R. 18 E. | R. 19 E.

335 000 FEET

T. 16 N.

(Joins sheet 38)

(Joins sheet 40)

(Joins sheet 45)

2 800 000 FEET

325 000 FEET

Fort Gibson Reservoir

Sequoyah Bay Recreational Area

Wildlife Refuge

Gibson

MISSOURI

KANSAS

TEXAS

PACIFIC

Clingham Creek

BORROW PIT

39

N

1 Mile

5000 Feet

Scale 1:20000

(40)

N

1 Mile 5 000 Feet

Scale 1:20000

(Joins sheet 32)

2 825 000 FEET

335 000 FEET

T. 16 N.

CHEROKEE COUNTY

WAGONER COUNTY

FORT GIBSON RESERVOIR

NEOSHO RIVER

FORT GIBSON DAM

Wahoo Bay

Sequoyah Bay

HeF HrC CkC BbB DnB DxE OkA DnC TaA HsF Ma Rc Ra

3 10 12 13 14 15 18

(Joins sheet 39)

325 000 FEET

2 805 000 FEET

(Joins sheet 46)

R. 19 E. R. 20 E.

WAGONER COUNTY, OKLAHOMA NO. 40

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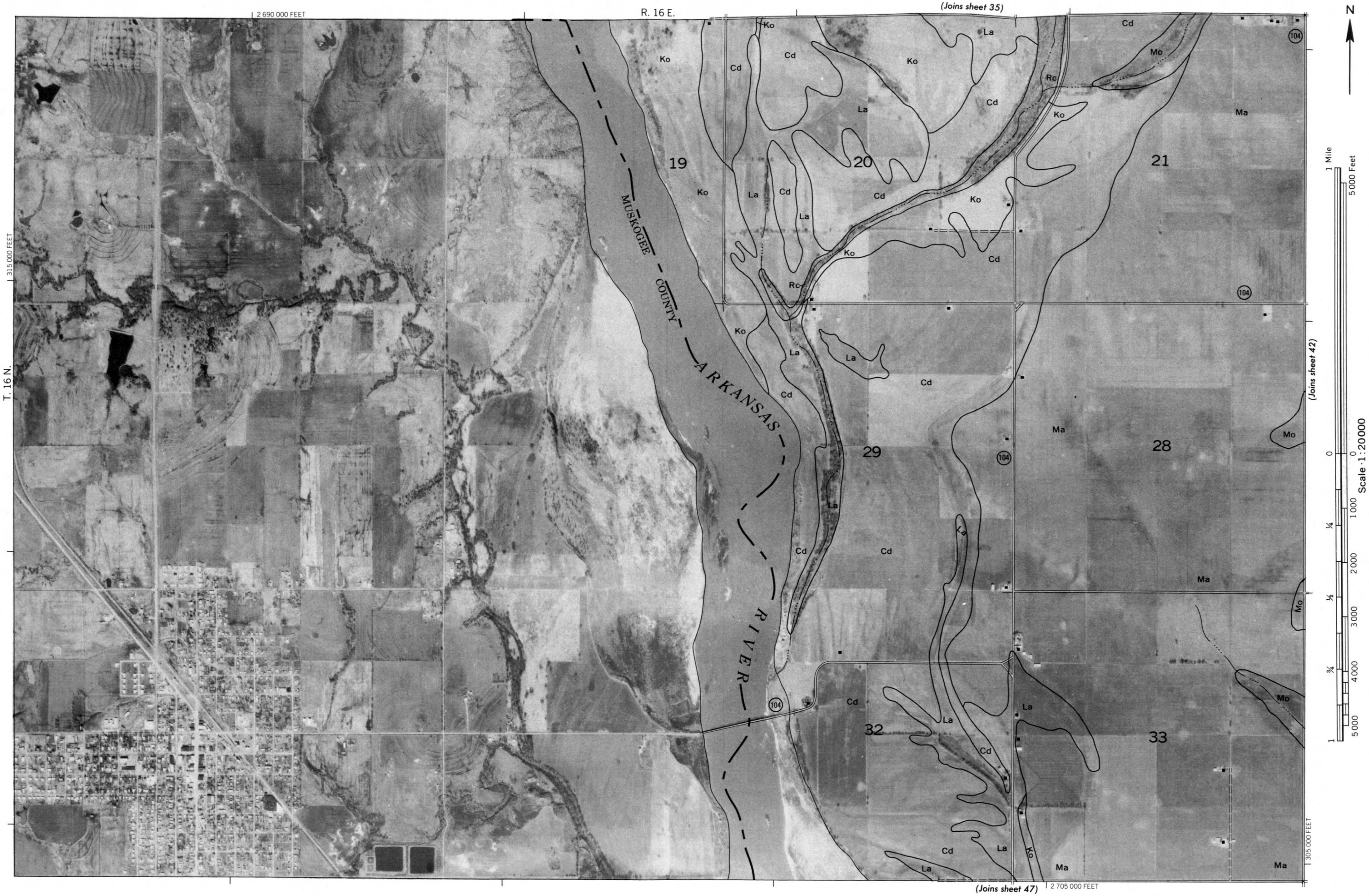
WAGONER COUNTY, OKLAHOMA NO. 41



WAGONER COUNTY, OKLAHOMA — SHEET NUMBER 42

42

N

R. 16 E. | R. 17 E.

2 730 000 FEET

320 000 FEET

T. 16 N.

(Joins sheet 36)

(Joins sheet 41)

(Joins sheet 43)

(Joins sheet 48)

2 710 000 FEET

305 000 FEET

1 Mile

5 000 Feet

Scale 1:20000

0 0

1 000 2 000 3 000 4 000 5 000

¼ ½ ¾ 1

22 23 24 19 20

27 26 25 30 29

34 35 36 31 32

DITCH

DRAINAGE DITCH

CHOSKA CEMETERY

BORROW PIT

Blue Creek

Springhill

Ma Mo Tu PaA QaB OaC ChB TaB TaA DxE KaE KfC OaB NeB OkA NeC NeC2 KfC2 KmB3 DnC2 Rc La

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WAGONER COUNTY, OKLAHOMA NO. 43

2 735 000 FEET

R. 17 E.

(Joins sheet 37)

320 000 FEET

T. 16 N.

(Joins sheet 42)

(Joins sheet 44)

(Joins sheet 49)

2 755 000 FEET

310 000 FEET

Clarksville

CLARKSVILLE CEMETERY

Pleasant Grove Church

MISSOURI

KANSAS

TEXAS

51B

B.P.

20 21 22 23 24 25 26 27 28 29 32 33 34 35 36

DxE NeC NeC2 TaB DnC2 BbC CsF CkC ChB PaA TaA DnB NeB OkA Bv HrC KfC2 KmD3 KfC HeF LnB OaC OaB Ra Tu La Mo Rc Ma

1 Mile

5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

N

(44)

N

1 Mile 5 000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

1 000 2000 3000 4000 5000

R. 18 E.

Ra

TaA

(Joins sheet 38)

2 780 000 FEET

320 000 FEET

T. 16 N.

310 000 FEET

2 760 000 FEET

(Joins sheet 43)

(Joins sheet 45)

(Joins inset, sheet 49)

CHOTEAU LOCK NO 17

VERDIGRIS R

OX BOWS OF THE VERDIGRIS RIVER

BORROW PIT

MUSKOGEE TURNPIKE

Creek

MISSOURI

KANSAS

TEXAS

ARKANSAS RIVER

MUSKOGEE COUNTY

Tullahassee

Fountain Church

PLEASANT GROVE CEMETERY

19 20 21 22 23 27 26 30 29 28 31 32 33 34 35

TaA TaB DxE Bv PaA NeC NeC2 Ra ChB Tu OaC OaB Rc Os Bug BaF OkA KfC2 HeF HrC KmD3 DnC DnC2 KfC KaE NeB Oy Cd Ko La Mo Ma

WAGONER COUNTY, OKLAHOMA NO. 44

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned

WAGONER COUNTY, OKLAHOMA NO. 45

46

N

(Joins sheet 40)

R. 19 E. | R. 20 E.

2 825 000 FEET

320 000 FEET

T. 16 N.

(Joins sheet 45)

310 000 FEET

2 805 000 FEET

MUSKOGEE COUNTY

CHEROKEE COUNTY

NEOSHO RIVER

CHEROKEE COUNTY

MISSOURI PACIFIC

Silos

Scale 1:20000

1 Mile | 5 000 Feet

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

19 22 23 24 25 26 27 34 35

CkC HeF HrC Rc Ra Ma HsF LnB Os OaB

WAGONER COUNTY, OKLAHOMA NO. 46

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture Soil Conservation Service and cooperating agencies.

Coordinate grid ticks and land division corners, if shown, are approximately positioned.

WAGONER COUNTY, OKLAHOMA NO. 47

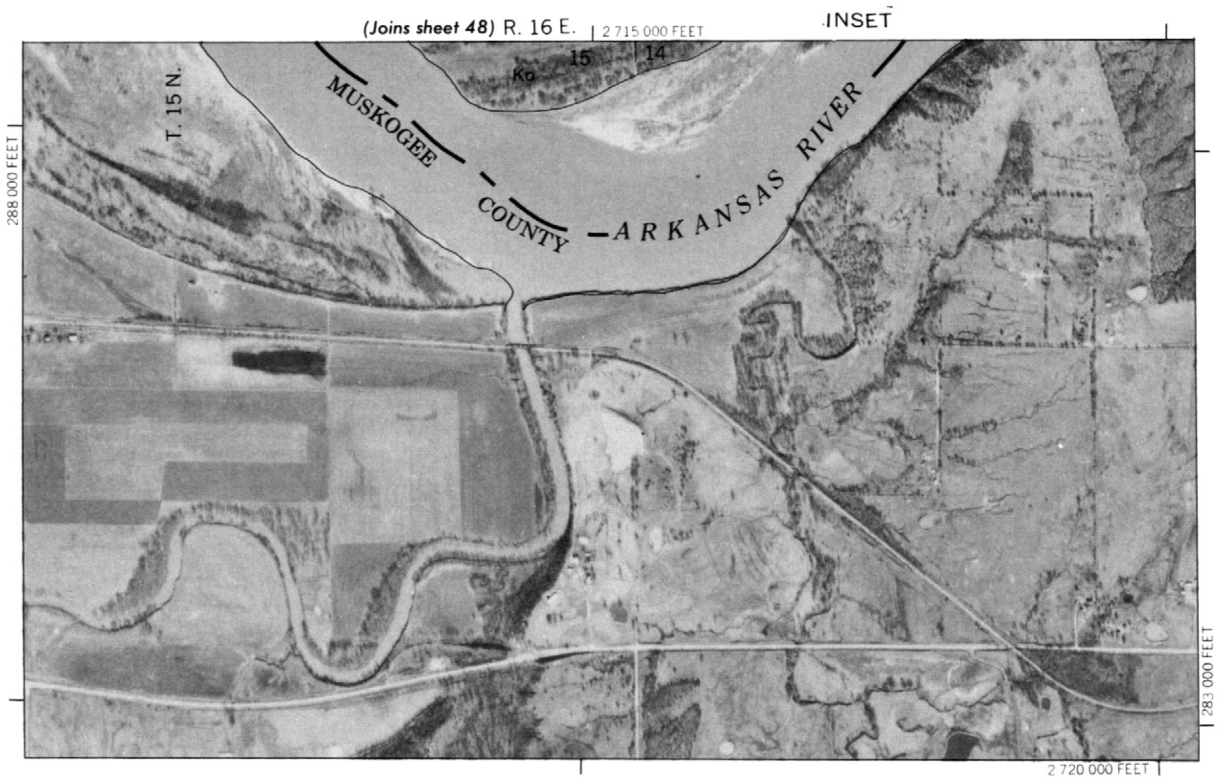
This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

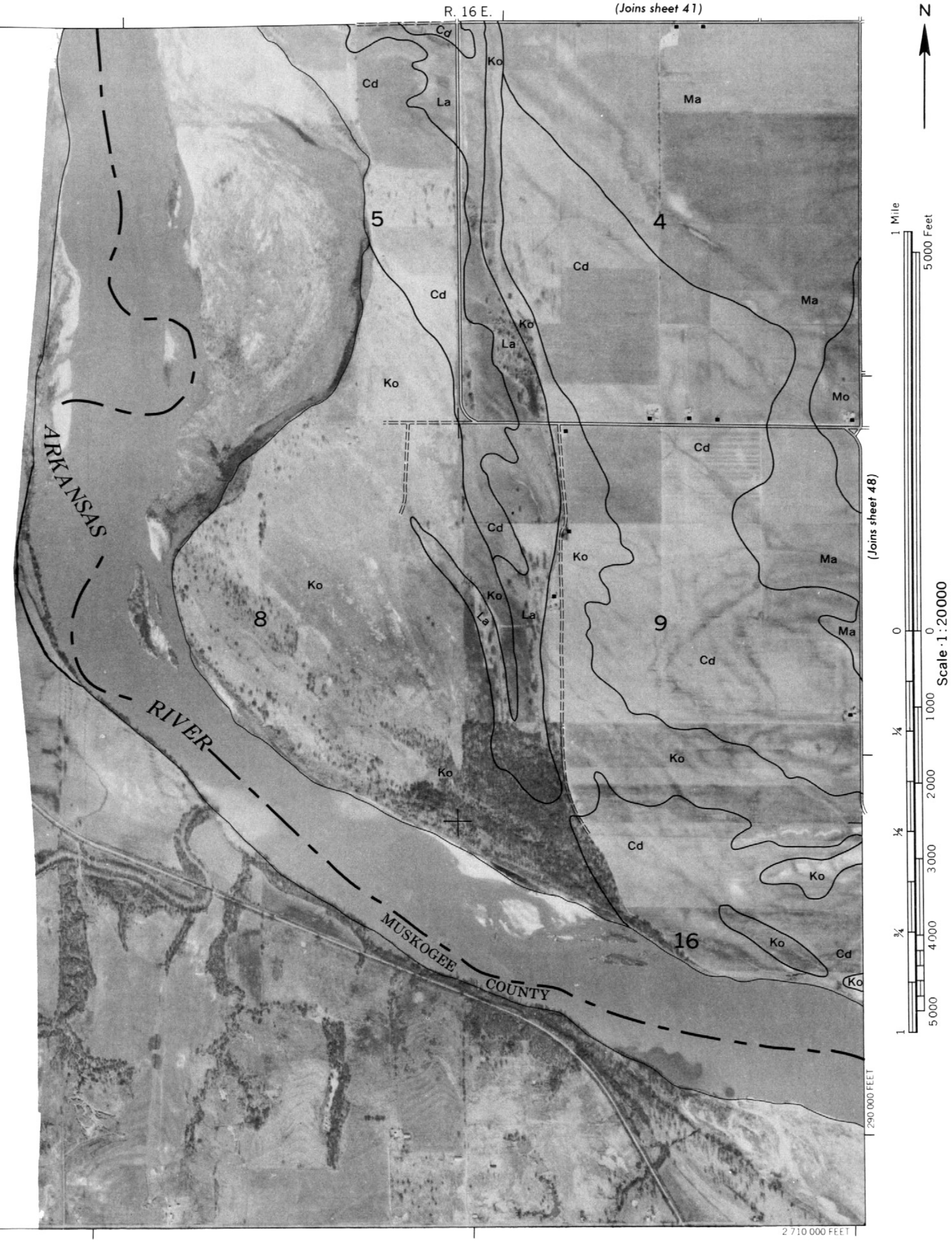
2 690 000 FEET

300 000 FEET

T. 15 N.

INSET





N

(Joins sheet 42)

R. 16 E. | R. 17 E.

2 730 000 FEET

305 000 FEET

T. 15 N.

(Joins sheet 49)

(Joins sheet 47)

1 Mile

5 000 Feet

Scale 1:20000

0 0

¼ 1000

½ 2000

¾ 4000

1 5000

290 000 FEET

(Joins inset, sheet 47) | 2 715 000 FEET

KfC KfC2 KaE OaB OaC DxE KmD3 Ok4 Mo Ma Tu Cd La Rc Ko

1 2 3 5 6 7 8 10 11 12 13 14 15

VAN CEMETERY

CHOSKA DRAINAGE DITCH

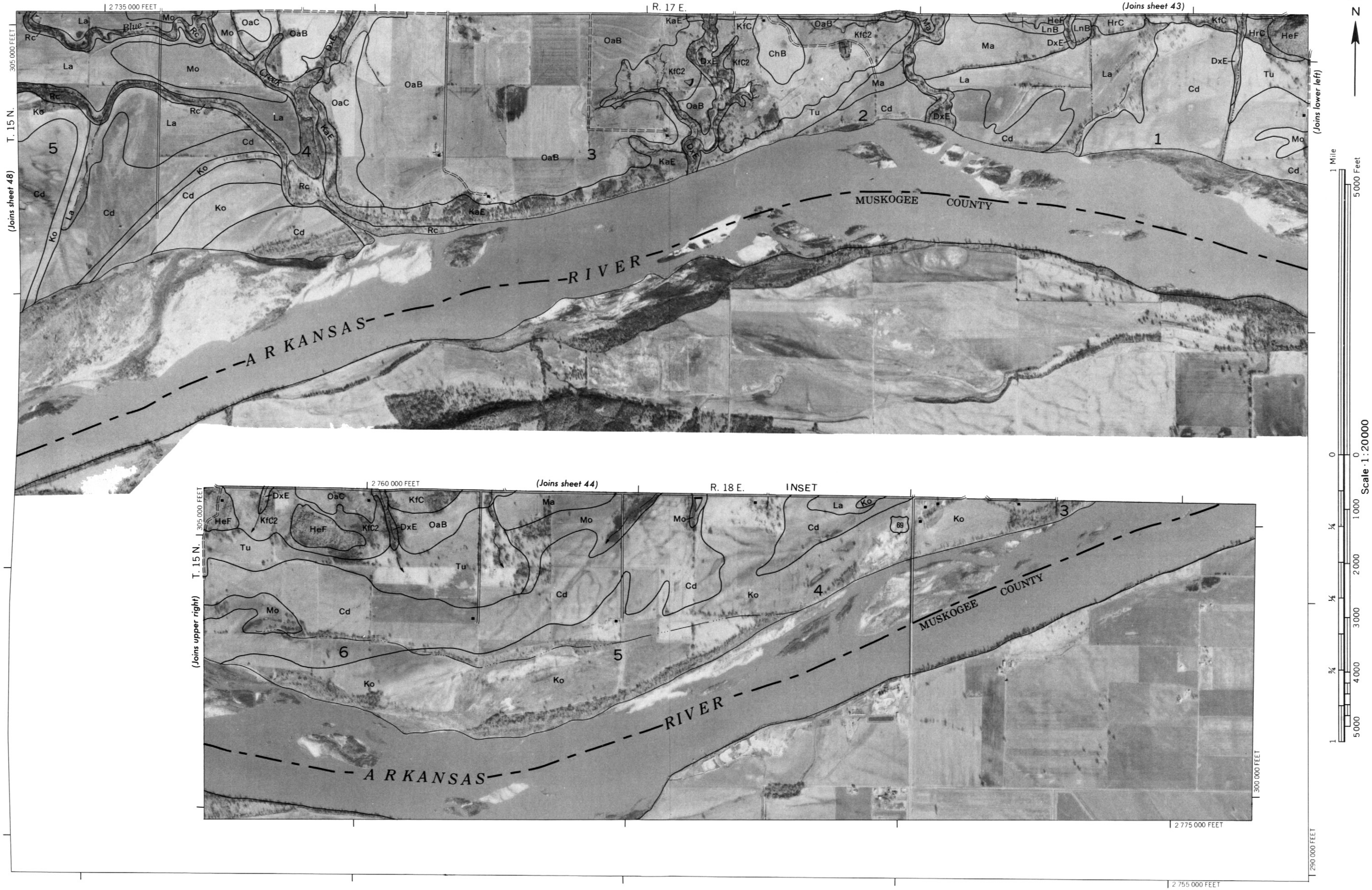
ARKANSAS RIVER

MUSKOGEE COUNTY

ARKANSAS RIVER-MUSKOGEE COUNTY

WAGONER COUNTY, OKLAHOMA NO. 48

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned



WAGONER COUNTY, OKLAHOMA NO. 49

This map is compiled on 1973 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.